Design Engineering

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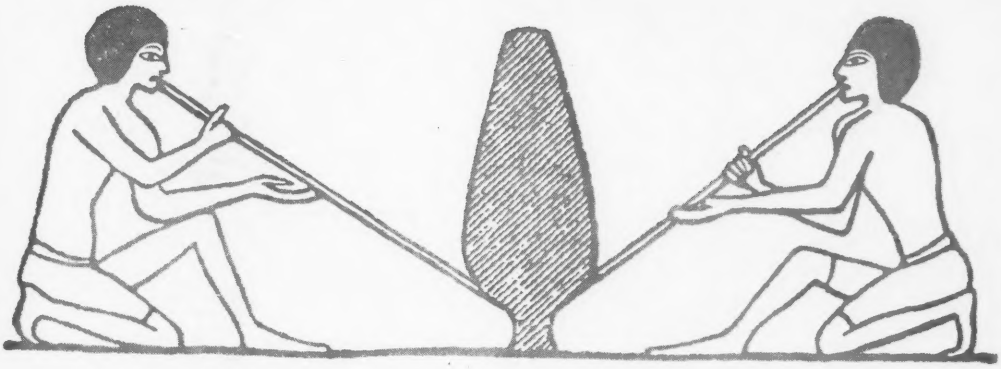
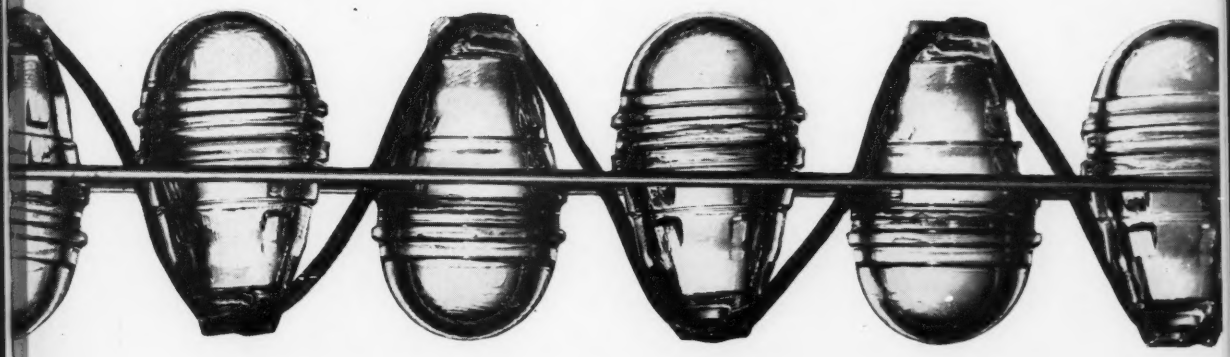


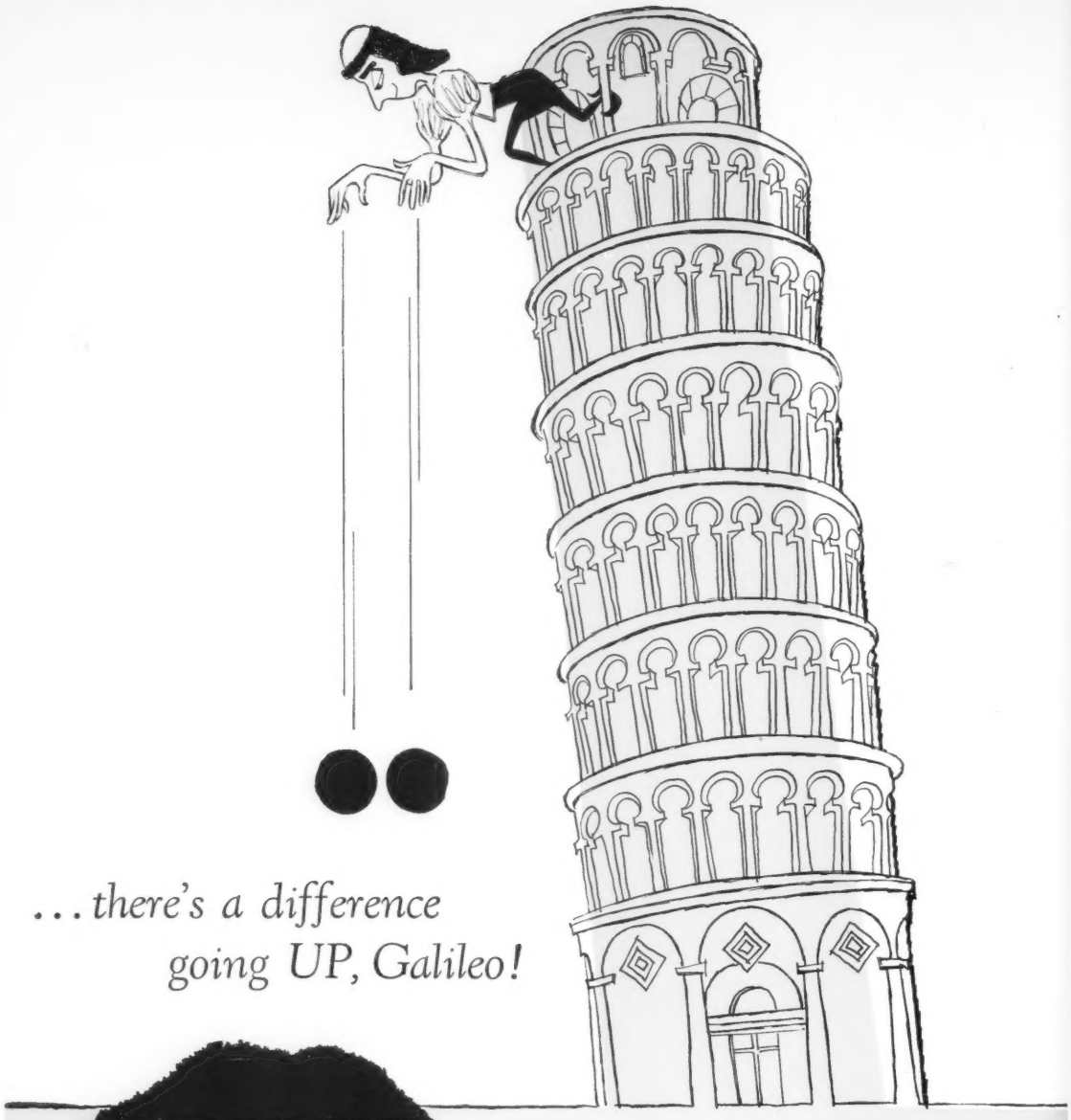
THE WONDERFUL EVOLUTION OF GLASS (page 27)



February 1956

Electric motors face up to a challenge
Vulcanized fibre's many uses
How to check for combined stresses

PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY, LIMITED, TORONTO, CANADA



. . . there's a difference going UP, Galileo!

GOING DOWN, bodies of different weights fall at the SAME speeds. The great Galileo spectacularly proved his theory over 350 years ago—dropping weights from the Leaning Tower in his native City of Pisa.

. . . but going up is altogether different—as the world of modern manufacturing and building appreciates.

The amazingly light weight of today's tough aluminum alloys, for example, makes possible speedier installation, cuts labor and shipping costs. Only one-third the weight of ordinary metals, strong, corrosion-resistant aluminum in ductwork, roofing and siding, and other applications—*goes up faster;* then lasts a lifetime!

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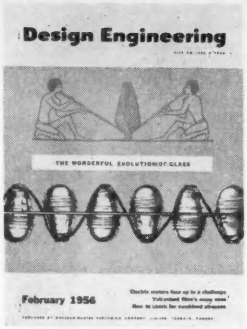

Design Engineering

VOL. 2 **FEBRUARY 1956** NO. 2

This month's cover

Haunting a glittering row of glass containers for shaped explosives, Egyptian craftsmen, genesis of the glass industry 4,000 years ago, rise faintly atop cover. Artist Des English pictorially resurrects two of the skilled blowers resplendent in authentically researched garb. The art of glass blowing is not a dead one exemplified in modern-day contrast by the "master gaffer" (page 2).

Design Engineering

MEMBER

CCAB

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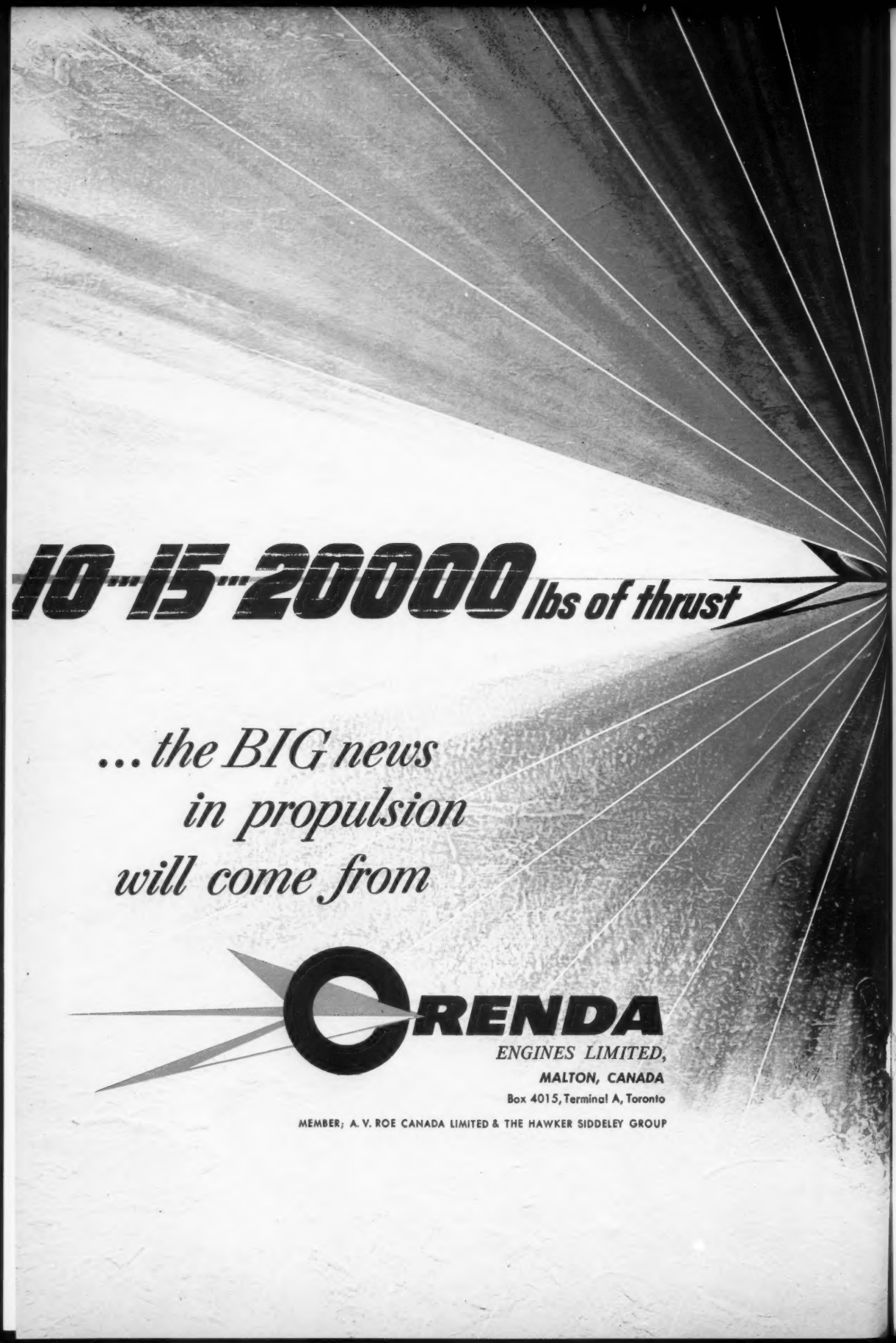
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Editorial correspondents in: The United Kingdom, the United States, Germany, France and Italy.

The March issue of **Design Engineering** will carry strong feature articles written by contributors no less experienced than those featured this month.

The Gas Turbine Car — How it works—Its design and development along with a complete report on its performance to date, is the subject of our cover and lead feature.

Noise and Its Measurement—The problems it presents to engineers and the way those problems are overcome will be another interesting article.

And the exciting story of what engineers are doing in an effort to cope with waters moving at hurricane-force is told in The Wave Tester report.

Special Artwork

Editorial layouts designed by art consultant **Desmond English.**

Lanning

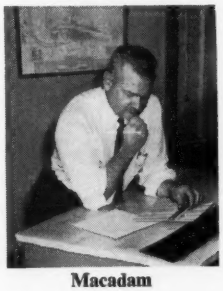
John Lanning who wrote our lead article on Glass is a Cornell University graduate of 1949 who joined the Corning Glass Works as a junior product engineer. He is now production engineering supervisor of the new components division of the company. Engineer Lanning is married with two children and relaxes by sailing and doing woodcarving.

Gerwin

Our special correspondent in Germany, **Robert Gerwin**, who studied physics and electrical engineering in Stuttgart, is close to design development in his own country and Western Europe. He is scientific editor for one of the largest popular technical publications in Europe, Das Magazin der Technik.

Morse

When the engineering editor saw a radioactive manipulator at a recent convention his penchant for trying new things was duly satisfied. **William Morse** is not only a top-flight mathematician and recognized stress expert—see his story on stress analysis (page 32)—but he is also a talented musician who once specialized in the saxophone. He has mastered the piano, guitar and clarinet as well as the outdoor sport of golfing which he plays with a handicap of 10. Member of numerous learned societies, editor Morse is author of a current book, "Principles of Aircraft Stressing," published by Charles Griffin.



Macadam

John Macadam, writer of the vulcanized fibre article on page 37 is a chemistry graduate of Haverford College and an alumnus of the Philadelphia Textile School where he specialized in chemistry and dyeing. Since 1935 he has been employed by the National Vulcanized Fibre Company and is presently an application and customer service engineer. Writer Macadam, his wife and three children live in Yorklyn, Delaware, where he is an active member of the American Red Cross and the Boy Scouts of America.

Reports

News in brief from the world's producers

ORILLIA—This Central Ontario town has become the headquarters for the world-wide operations of a new engineering firm known as **Dorr-Oliver-Long Ltd.,** a consolidation of the Canadian operations of E. Long Ltd., here and Dorr Oliver Inc. of the U. S.

President of the newly formed company, C. R. Long, a former director of Dorr-Oliver said: "Our consolidation is the result of several months' careful study—a culmination of an extremely close relationship between the companies."

Two years ago the Dorr Co. of Stamford, Conn., and Oliver United Filters, Oakland, Calif., merged. Both companies had had a long-term association with the Long company. Since 1911 they had manufactured Dorr equipment and had been producing for the Oliver company since 1930.

"Our consolidation, which was effective January 1, will strengthen the over-all operations of both the Canadian and U. S. companies," President Long observed.

The company would, he added, maintain divisional sales offices in Toronto and in Vancouver.

Dorr-Oliver has been supplying a broad line of equipment and engineering services to the metallurgical, chemical, pulp and paper, industrial and sanitation fields around the world. With its offices, subsidiary companies, representatives and resident engineers it covers such far-flung areas as Europe, Central and South America, Australia, India, Hawaii and the Philippines. There are factories in Hazelton, Pa., Oakland, Calif., and Denver, Col.

In many countries abroad equipment has been produced locally through the development services of the company and then marketed by their world-wide technical staff.

Orillia manufacturing facilities of the new company consist of machine shops, structural steel shops and a Meehanite foundry with ample room for pattern storage.

In a new chapter of Canada's industrial progress, the fathering of big business the world over, the 500-employee Orillia firm will be prepared to skilfully assume its role.

• • •

HAMILTON—The birth of Noduloy — the name that **Canada Iron Foundries, Ltd.,** has given nodular or ductile iron is a dramatic event; it is a vital foundry process culminated by a blinding flash of magnesium, ignited by molten metal poured from an electric furnace into a ladle.

The company's new special products plant here, equipped with melting units giving the widest possible flexibility, is cradle for the production of Noduloy, stronger than grey iron and many times tougher. Yet in some varieties the metal is so ductile that it can be bent and twisted without breaking.

Most of the production of Domite alloy irons and nodular ductile irons that were previously cast in other Canada Iron foundries will be concentrated in the new operation.

In full production the plant will produce four tons of alloy iron every hour.

The new facilities will also make it possible to make castings of certain alloys that could not be handled at other foundries belonging to the company. One of these is Noduloy Ni-Resist, newest member of the nodular iron family whose arrival was announced last May.

With high nickel content it retains the corrosion resistance of standard Ni-Resist, yet has the toughness and strength approaching stainless steel.

What will the new plant do for Canadian industry expansion in the 1956 picture of progress? The availability of nickel in Canada for the production of Ni-Resist alone augurs well in the forecast of J. W. Thomson, head of the new plant.

"A broad new field for the development of industrial applications of alloy iron is opened in Canada," he asserted.

Nickel, he explained, is more easily obtained in Canada than by the U. S. foundry companies.

FORT SASKATCHEWAN — A unique $24,000,000 plant developed by **Sherrit Gordon Mines Ltd.,** is refining ore concentrates from Manitoba's Lynn Lake area by an entirely new chemical process.

The new "chemical" nickel refinery bypasses the usual roasting, smelting, electrolytic and fire refining.

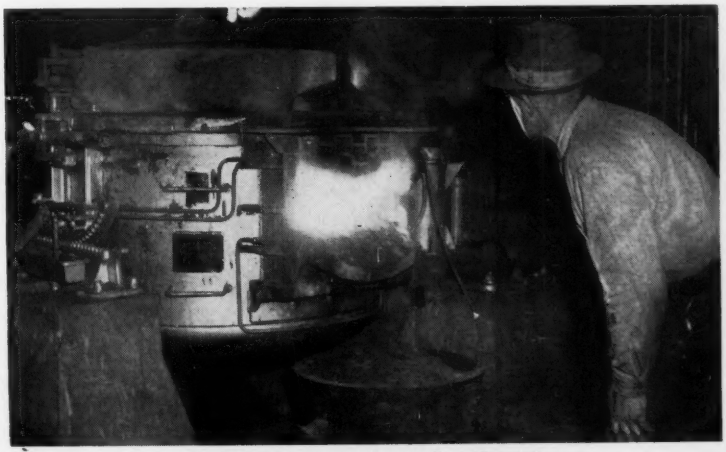
Since poisonous hydrogen sulfide is generated at one step in the process, personnel must be protected from the fumes. To do this a Titrilog produced by **Consolidated Aerodynamics Corporation** is used to monitor the atmosphere in the building where the hydrogen sulfide is produced. Monitoring other than by humans is essential since the gas deadens the sense of smell.

The Titrilog warns of a dangerous concentration of hydrogen sulfide in the building both by recording and indicating concentrations as low as one part in 10 million. Similar reactions are obtained from sulfur dioxide, mercaptans, thiophene and organic sulfides and disulfides.

In the Titrilog the basic reaction is an oxidation-reduction between the sample and the free bromine. The endpoint is kept automatically as a constant value by means of sensing electrodes which match the bromine generation to the reactive compound absorption. The bromine-generating current, which is recorded, varies directly with the amount of sulfur compounds in the sample stream.

The machine's reaction cell is part of an inverse-feedback-type electronic amplifier. Signal input to the amplifier is supplied by the sensing electrodes, and the amplifier output current generates the bromine.

Safeguarding the health of employees by precautions like those at the Sherrit Gordon refinery typify the action of progressive management in Canada and the U. S. where the health protection monitor has found increased applications.



An electric furnace at Canada Iron Foundries.

cae*

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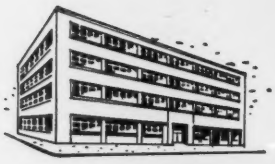
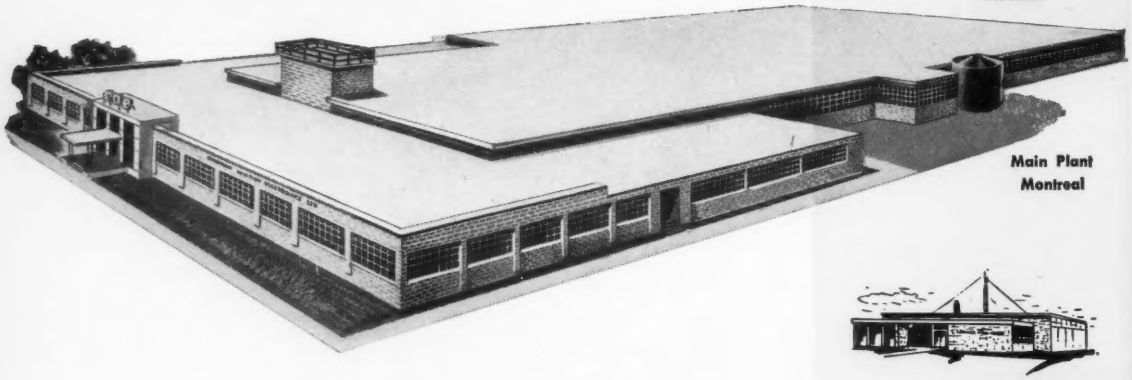
...with Canada's most modern electronic facilities and largest team of electronic engineers and technicians.

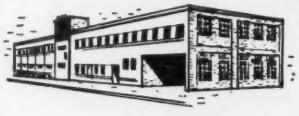


Consumer Products Division Montreal

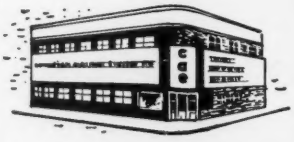


Main Plant Montreal

Toronto



Winnipeg



Vancouver

cae's five modern electronic plants—in Montreal, Toronto, Winnipeg and Vancouver have been located to serve the needs of Canada's rapidly expanding economy in a most efficient manner.

With these extensive facilities at their command, CAE's large and versatile team of electronic engineers and technicians has designed and produced some of the world's most advanced and complicated electronic devices.

As consumers, Canadians benefit too, from CAE precision built products such as famous quality CAE Du Mont Telesets and revolutionary "Sonoramic" True Fidelity radio-phono combination sets which have ushered in a new era in home entertainment.

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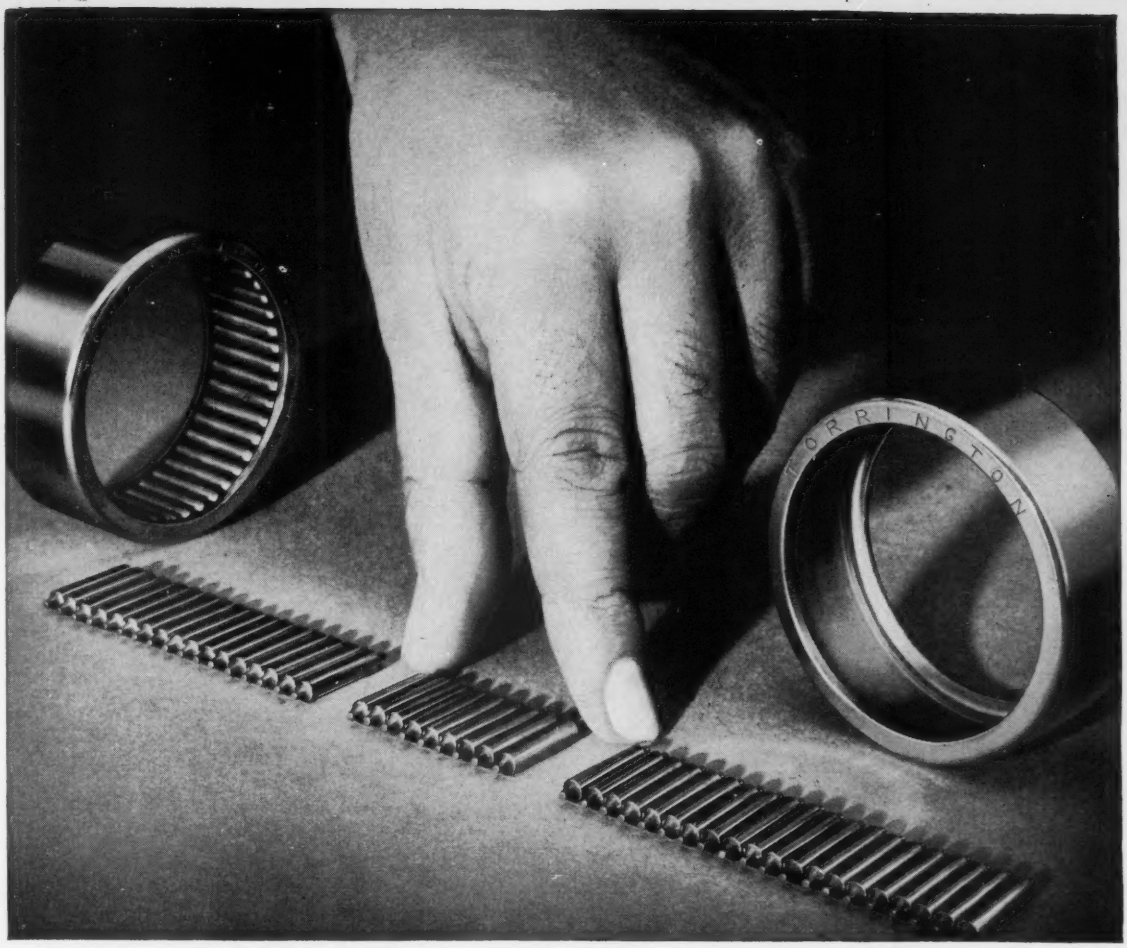

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The radial load capacity of an anti-friction bearing depends, in the final analysis, on the number of lines or points of contact made by the bearing surfaces in the load zone. This is where the Torrington Needle Bearing really shines.

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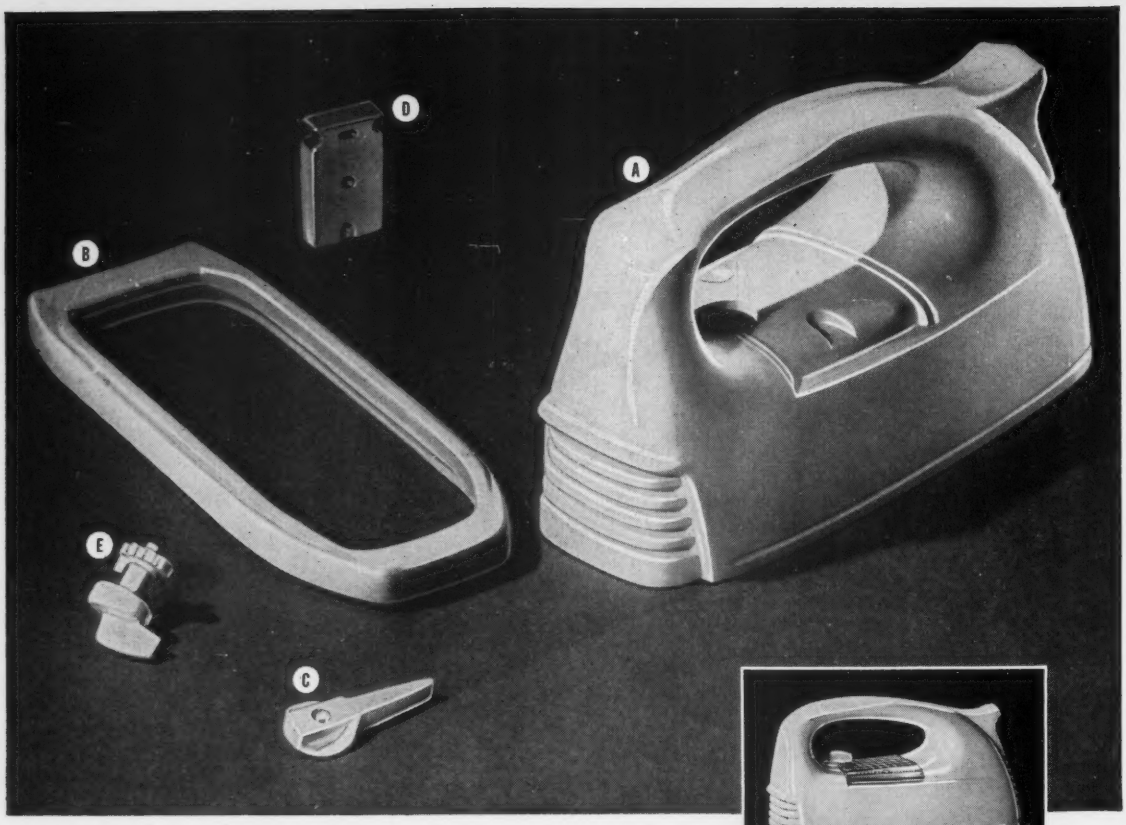

Why five plastics were used in one food mixer?

C.G.E. has discovered that in most instances a combination of plastics turns out the finest, yet most economical, finished product. For instance five different plastics properly molded were used to produce this popular food mixer.

There are many advantages in having C.G.E. solve your plastic molding problems. We have the facilities to fabricate any type of plastic material and the know-how as to what plastics to use. Call C-G-E Plastics Advisory Service. They will co-operate with your engineering, production and sales people to give your line added sales punch. Contact: Plastics Advisory Service, Canadian General Electric Co. Ltd., Cobourg, Ontario.

A — MOTOR ENCASEMENT in Hercocel Acetate. Fire and break-resistant . . . gleaming white finish. Resists food and fruit juice stains.

B — GASKET in Vinyl Plastic. Had to be exceedingly flexible. Resistant to oils and fats . . . easily cleaned.

C — EJECTOR LEVER in Urea Plastic. Very sturdy . . . in white . . . shows no wear though beaters are inserted and ejected constantly.

D — SWITCH BASE in Phenolic Plastic. Low cost . . . high dimensional stability . . . noted for its electrical properties.

E — CONTROL KNOB in Hy-impact Polystyrene Plastic. Very tough . . . in white . . . ideal for this part that is frequently handled. Low in cost.

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451W-355

CANADIAN GENERAL ELECTRIC COMPANY LIMITED

TOOLS AND HARDWARE LIMITED HAD A PROBLEM

Tools and Hardware Limited of Orillia, Ontario are the makers of well known "Chromex" solid brass, chromium-plated bathroom accessories. As in the case of so many other manufacturers their most expensive operation is polishing. Management began looking for some way to cut this heavy cost.

Anaconda came through with the answer—*Formbrite*, a superior, fine-grained drawing brass that actually helps to polish itself.

In the opinion of Harry Tissington, President of Tools and Hardware Limited, Formbrite is effecting an overall saving of from 10-15% in the cost of finishing "Chromex" fittings.

ANACONDA had the answer— "Formbrite"!

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Silicone News

FOR DESIGN ENGINEERS

Hydraulic Tool "Winterized" With Dow Corning 200 Fluid

The instability of most fluids has been the limiting factor in designing compact hydraulic systems or hydraulic devices exposed to even seasonal changes in temperature. During the past decade, the accuracy and usefulness of hydraulic devices has been greatly increased through the use of Dow Corning 200 Fluids with their incomparably flat viscosity-temperature slopes. Here's a new example of product improvement through the use of silicone fluids.

For splicing electrical high lines, Burndy Engineering Co., Norwalk, Conn., manufactures a portable hydraulic tool called "Hypress". It weighs only nine pounds but develops a force of 18,000 pounds.

Although widely accepted by utility companies, the usefulness of the Hypress was limited because the organic oil became so thick at low temperatures that it could not pass freely through the port and valves. Even at 20 F the viscosity of this oil increased to 2400 Saybolt seconds.

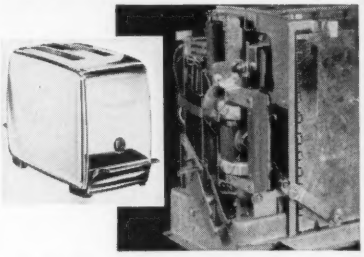
Faced with the problem of "winterizing" the standard Hypress for operation at temperatures down to —30 F, Burndy engineers developed a special packing only to find that low temperature organic oils caused excessive swelling. Then they tried a 20 centistoke Dow Corning 200 Fluid with a viscosity of only 420 Saybolt seconds at —30 F and 68 seconds at 130 F.

The silicone fluid filled unit operates just as easily at —30 F as organic oil-filled units do at room temperatures. Swelling of the packing is eliminated. Utilities now use the Hypress in all seasons with equal ease. Field checks made since 1950 show that the investment made in Dow Corning 200 Fluid has been repaid many times over in additional sales resulting from dependable year around service. *No. 68*

SILICONE INSULATED MOTOR MAKES "POWER ACTION" TOASTER POSSIBLE

When a slice of bread is placed in a "Power Action" Toastmaster, the silicone insulated motor automatically lowers it and at the same time stretches a coiled spring with a 1½ pound pull. After the toasting cycle, this spring is released and the toast is gently elevated with the motor serving as a damping device.

In this, the first completely automatic toaster, the small but powerful motor gets "toasted" with every slice of bread. Ambient temperatures are in the range of 400 F and operating time is one-third of a second during each toasting cycle. Accelerated life-testing by McGraw engineers indicates a life expectancy of 30 years under normal conditions of use. In the course of gaining Underwriters' approval these motors withstood a continuous locked rotor test for 8 hours without failure.

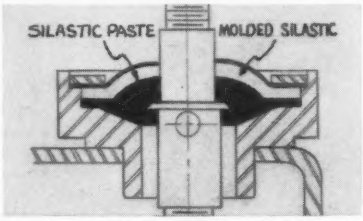


McGraw Electric also uses squares of silicone-glass laminate as an insulating material between the frame and the mica supports for the heating elements. Before this silicone-glass laminate was used, leakage current from the heating elements through the mica to the frame was 2.5 milliamperes. Now leakage current is practically zero. Fabricated by National Vulcanized Fiber Co., this laminate has excellent uniformity and bond strength.

As added protection against moisture absorption and current leakage, all ceramic parts of this new Toastmaster are treated with Dow Corning 200 Fluid. *No. 71*

Hermetic Seal Produced With Silastic

Low temperature flexibility of vulcanized Silastic*, plus the unique flowing and curing characteristics of this silicone rubber in paste form, have helped Electro-Snap Switch & Mfg. Co., Chicago, develop an unusually efficient, hermetically sealed limit switch.



The "wobble seal" diaphragm in this low temperature switch is comprised of an inner mass of Silastic paste, a layer of molded Silastic and a top coating of Teflon. On curing, the Silastic paste vulcanizes in place to form a resilient and moisture-proof seal between case and actuator.

The Teflon coating protects this seal from possible exposure to aromatic hydrocarbons and reduces the adhesion of ice. Electro-Snap reports more than a million cycles of actual service without a leak in the seal. *No. 69*

*T M REG U. S. PAT. OFF.

New 1956 Reference Guide to Dow Corning silicone products briefly reviews properties and applications of silicone products most widely used. Indexed by application, this all-new guide will prove a definite aid to design engineers concerned with product improvement and cost reduction. *No. 70*

Design Edition 17

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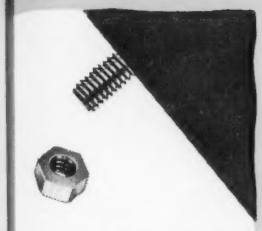
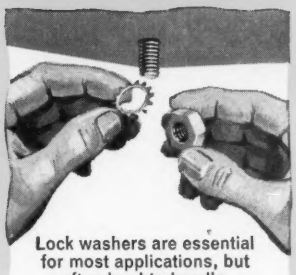
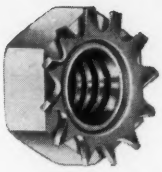


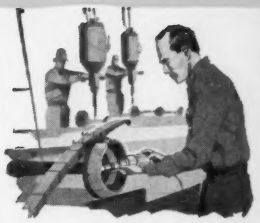
Loosening of ordinary nuts due to vibration is both dangerous and costly.



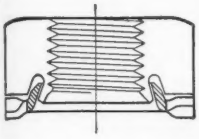
Lock washers are essential for most applications, but often hard to handle.



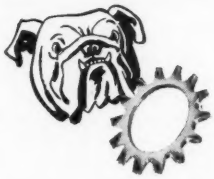
. . . except when nuts and lock washers are PRE-ASSEMBLED . . . as KEPS.



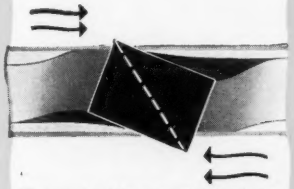
Then, awkward and costly separate lock washer handling is eliminated.



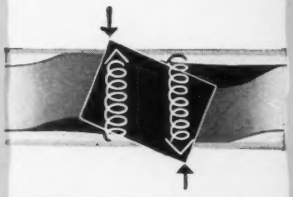
Nut and lock washer are mechanically pre-assembled as an integral unit.



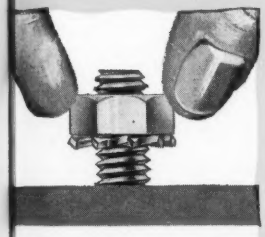
Shakeproof Lock Washers on KEPS lock tight because the teeth bite.



Tapered-twisted teeth bite deep to set up powerful resistance to any backward rotation.



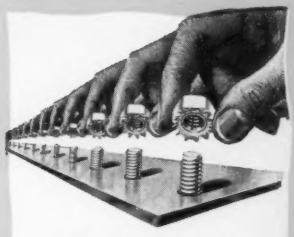
Spring tension makes each tooth bite even deeper as vibration increases.



arting KEPS is easier . . . Free running action makes driving faster, saves assembly time.

Washers can't drop off, can't be wasted or "forgotten."

Standards and specials meet a wide variety of requirements.



With KEPS, you get tight, efficient fastening every time.

Free Sample Kit

ow . . . make your own tests! See for yourself how KEPS can save time in the assembly of your product. Write for your free sample kit today!

citco

CANADA

ILLINOIS TOOLS LIMITED

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WORLD'S BROADEST LINE OF ASS-ASSEMBLY FASTENINGS

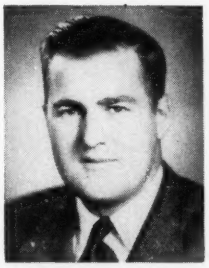
Announcing

a new source of aluminum

DIE CASTINGS

In keeping with its policy of advancing in pace with Canada's expanding economy, the Hoover Company Limited, Hamilton, Ontario, is proud to announce the formation of a Hoover Commercial Die-Casting Division.

Hoover has been producing die castings for its own consumption for some time . . . and is now following the pattern set by the Hoover Company of North Canton, Ohio. As the American Company has been among the leaders in the Aluminum Die-Casting Industry for almost 35 years, a close liaison will be maintained between the Canadian and American operations to assure the highest possible standards of quality and service.



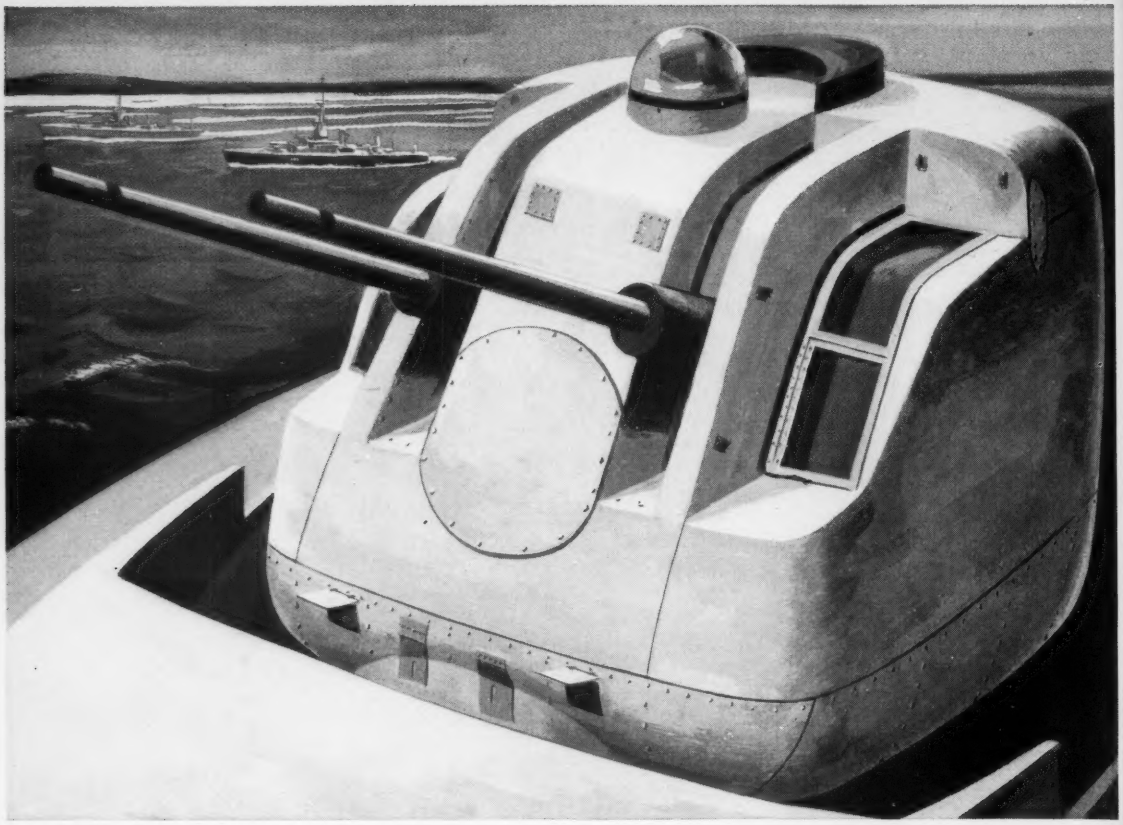
James A. McVean, Sales Manager of the new Hoover Commercial Die-Casting Division.

Your enquiries will receive prompt and courteous attention . . . please feel free to write or phone at any time.

HOOVER

commercial die-castings division

The HOOVER COMPANY LIMITED
Hamilton Ontario



Vibrin joins the Navy

IN THE PAST FEW YEARS the Royal Canadian Navy has pioneered many new developments. One of the most interesting is the gun shield for the 3"/50 mount, shown above, made of reinforced Vibrin.

Vibrin, Naugatuck's polyester resin, offers several advantages in this application. Its strength — when reinforced with fibrous glass — is many times greater than that of steel on a weight basis, so the gun shield and mount can combine light weight with greater resistance to shrapnel and shell penetration. Reinforced Vibrin is also completely immune to corrosion from salt water.

Another advantage of reinforced Vibrin is the ease with which difficult parts can be molded. Original molds are simple and economical to make, and no heat or pressure are required in molding.

All these advantages have caused Vibrin to be used in many other applications besides naval gun shields and mounts. Car and truck bodies, machine housings, boats, chemical piping, and translucent sheeting are just a few.

Vibrin may be the material you need to improve your present products, to cut manufacturing costs, or to give reality to ideas which might otherwise be impracticable. Why not find out, by calling Naugatuck Chemicals in Elmira, Ontario, or branches shown below?

Other NAUGATUCK Plastics:

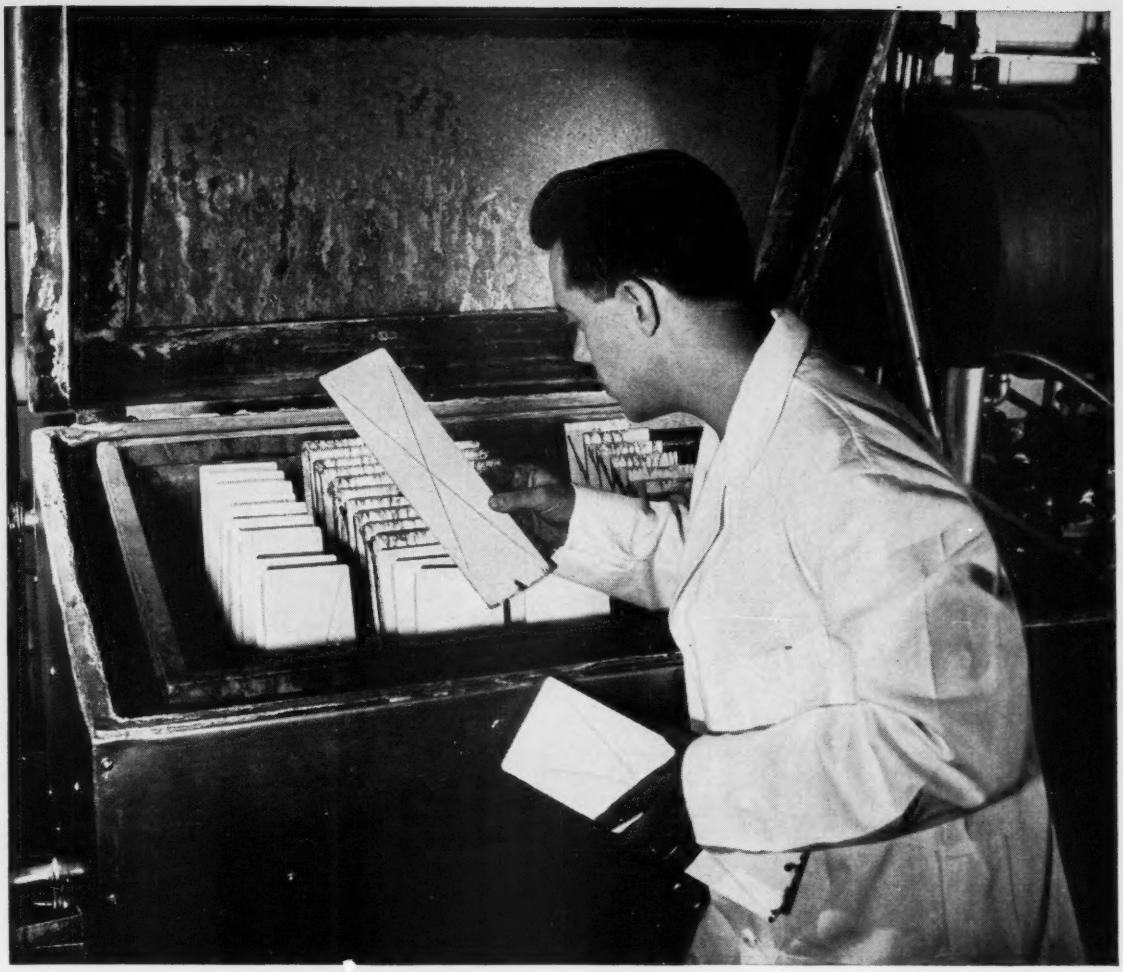
MARVINOL

Vinyl resins offering good physicals, easy processing, low temperature flexibility, and resistance to oils, acids and wear.

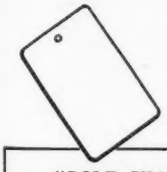
KRALASTICS

Molding and extrusion compounds combining rigidity with exceptional toughness.

Naugatuck Chemicals
DIVISION OF DOMINION RUBBER COMPANY LIMITED
Plant & Sales: ELMIRA, Ont.
Branches: Montreal · Toronto · Winnipeg



When you want close quality control, *you use Bonderite under the paint.*



"GOLD STANDARD" PANELS are Bonderized Parker's Customer Service lab prepares Bonderite-treated panels, used as the standard of comparison by manufacturers and paint companies. We have shipped about 400,000 in the last 12 months.

● The test panels in the plant laboratory tell the story: Bonderite in the finish line is the quality control engineer's friend. Performance standards are more easily maintained. And when standards are maintained in the plant, product performance in the field will please your customers.

The secret of Bonderite's uniform results begins in Parker manufacturing plants, where each lot of chemical is numbered and tested. A sample is kept permanently. Operating procedures for processing are simple, easily followed, easily checked. Long experience has smoothed out all the kinks!

Take the most positive way to control quality and assure finest paint finish, durability and appearance—use Bonderite.

**Bonderite, Bonderlube, Parco, Parco Lubrite, Parker Pre-Namel—Reg. U.S. Pat. Off.*

PARKER RUST PROOF COMPANY
OF CANADA, LTD.
REXDALE BLVD., REXDALE (ONTARIO), CANADA

Since 1915—leader in the field

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

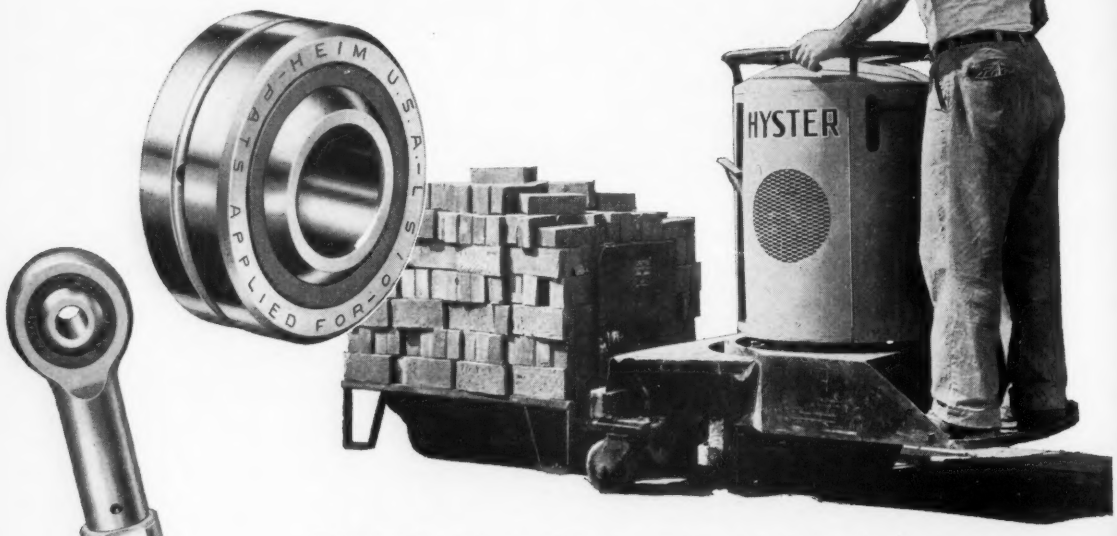
Throttle Control...

Simplified with

HEIM *Unibal* BEARINGS

When the new improved Hyster Turret Truck was introduced, some of the improvements included simplification and strengthening of the throttle control mechanism.

More durability, longer life, and trouble-free service were accomplished through the wider use of Heim Unibal Bearings — often referred to as spherical self-aligning bearings.



THE SINGLE BALL CORRECTS MISALIGNMENT IN EVERY DIRECTION.

Heim Unibal Spherical Bearings and Rod Ends are the solution to most problems of transmitting motion at varying angles. Rod Ends are available in a complete range of bore and thread sizes in both male and female types.

Write for Complete Catalog and a free sample of Unibal.

R&M BEARINGS CANADA LTD.

QUEBEC CITY	MONTREAL	WINNIPEG	THREE RIVERS	TORONTO	VANCOUVER	LONDON, ONT.	HAMILTON
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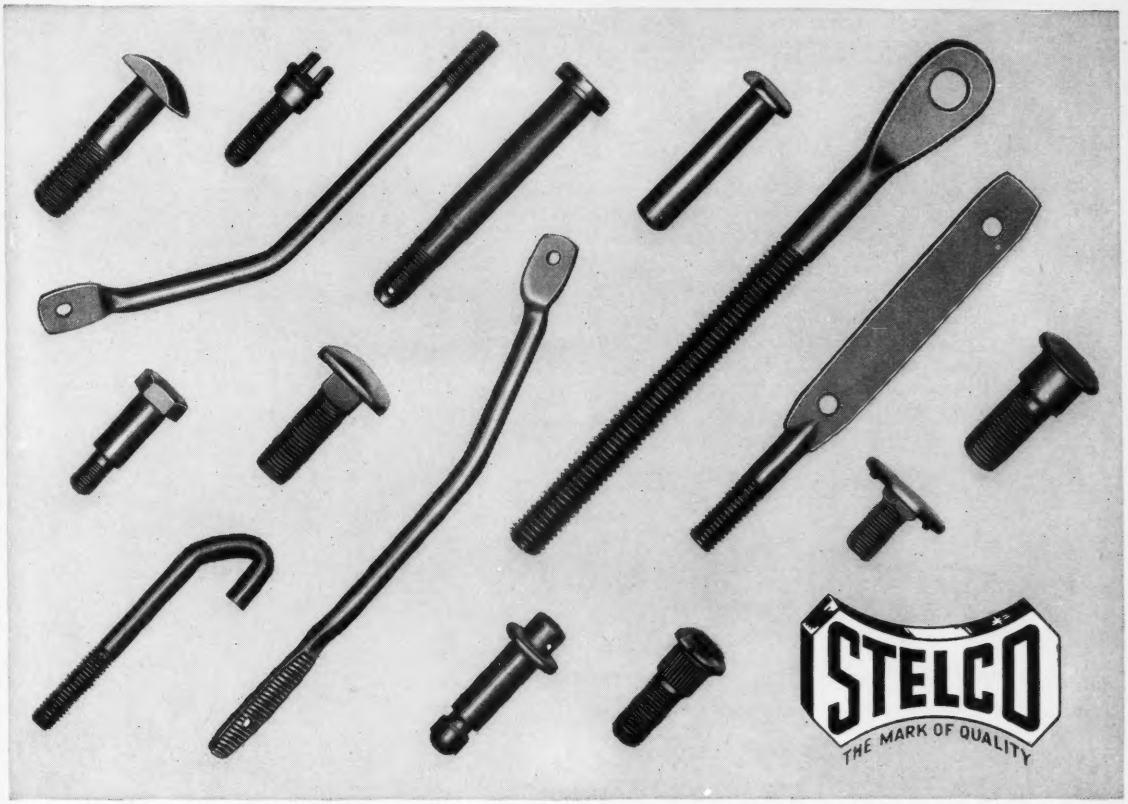
FACTORY REPRESENTATIVES AND DISTRIBUTORS FOR CANADA

What's New for You . . .

IN STELCO'S EXPANDING FACILITIES FOR

Special Fasteners ?



The "specials" shown illustrate some of the many processes that Stelco's four bolt plants are equipped to perform. Stelco's engineers co-operated with designers in industry to produce these pieces — and hundreds of others — to show initial cost savings, reduced assembly time, and improved product strength and appearance.

In most cases these parts are cold headed or cold worked. Fasteners with eccentric contours — for example, offsets, wings, flats, or ovals — can be readily made. Quality is high, because only material that is free from all defects is suitable for upsetting and extruding. Unit costs are low, because production rates are high . . . and because the cost per pound of coiled wire for heading is much lower than that of bar stock for machining.

Stelco's Engineering Service is at your disposal. If you use parts comparable in any way to those shown, Stelco can probably save you money. Your enquiry will be handled promptly by any Sales Office.

INDUSTRIAL FASTENERS INSTITUTE

THE **STEEL COMPANY OF CANADA,** LIMITED

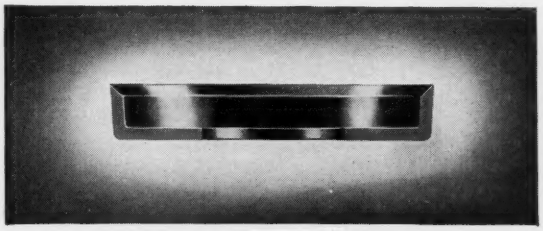
EXECUTIVE OFFICES: HAMILTON — MONTREAL

Sales Offices: Halifax, Saint John, Montreal, Ottawa, Toronto, Hamilton, London, Windsor, Winnipeg, Edmonton, Vancouver. J. C. Pratt & Co. Limited, St. John's, Newfoundland.

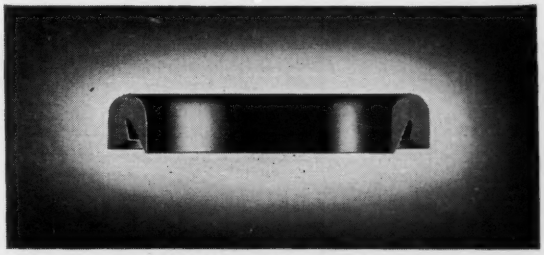
55122.B

Simplify your sealing problems...

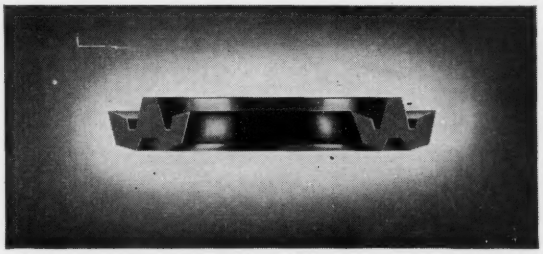
with Johns-Manville Precision moulded packing designs for pressure applications in hydraulic and pneumatic equipment



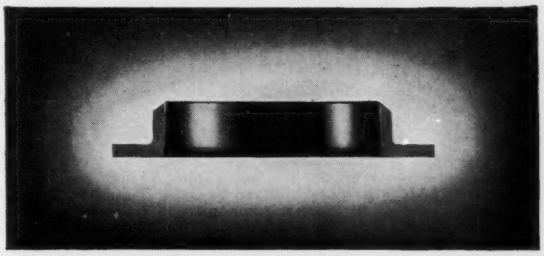
1. Type "A" Packing Cups for pistons
(the original "square heel" cup design)



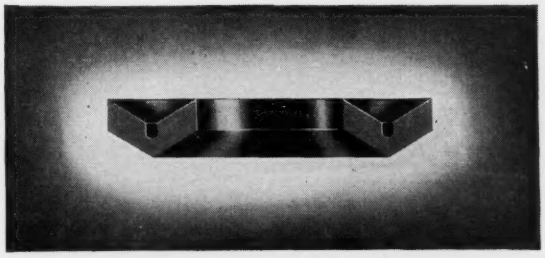
2. Sea Ring packing for rods



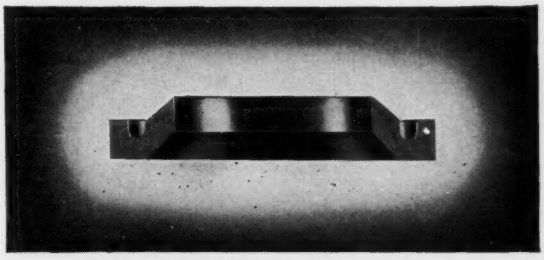
3. Uneepac Packing for rods and pistons



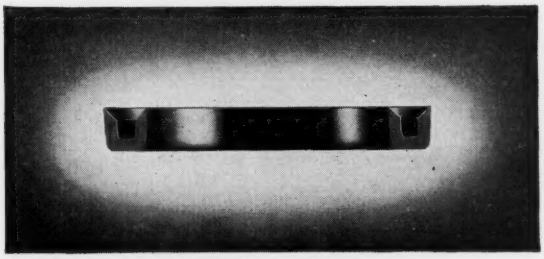
4. Hat Cup Packing for rods



5. V-Rings packing for rods and pistons



6. Cumpac #239 packing for rods



7. U-Cup Packing for rods and pistons

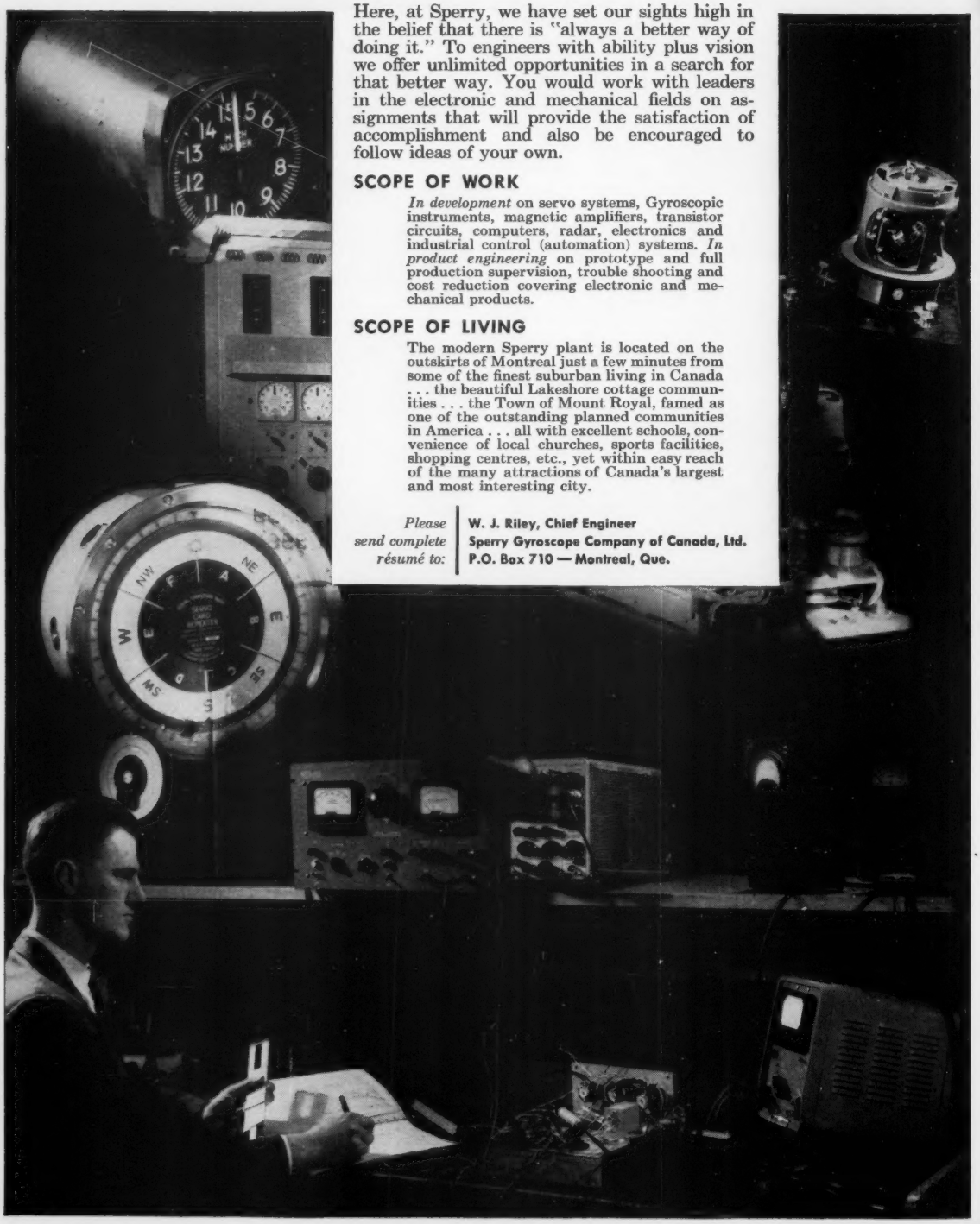
THE WIDE VARIETY of Johns-Manville Packing designs enables you to handle practically any sealing problem. The designs shown on this page are obtainable in a broad range of standard sizes and in materials designed for either usual or special service conditions encountered in hydraulic and pneumatic equipment. Johns-Manville also produces oil seals, moulded gaskets and miscellaneous shapes to specification. See your local J-M distributor or J-M sales office for product or engineering data. Or write Canadian Johns-Manville, 565 Lakeshore Road East, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville MOULDED PACKINGS

1-1061

SPERRY OFFERS SCOPE TO ENGINEERS WITH VISION



Here, at Sperry, we have set our sights high in the belief that there is "always a better way of doing it." To engineers with ability plus vision we offer unlimited opportunities in a search for that better way. You would work with leaders in the electronic and mechanical fields on assignments that will provide the satisfaction of accomplishment and also be encouraged to follow ideas of your own.

SCOPE OF WORK

In development on servo systems, Gyroscopic instruments, magnetic amplifiers, transistor circuits, computers, radar, electronics and industrial control (automation) systems. *In product engineering* on prototype and full production supervision, trouble shooting and cost reduction covering electronic and mechanical products.

SCOPE OF LIVING

The modern Sperry plant is located on the outskirts of Montreal just a few minutes from some of the finest suburban living in Canada . . . the beautiful Lakeshore cottage communities . . . the Town of Mount Royal, famed as one of the outstanding planned communities in America . . . all with excellent schools, convenience of local churches, sports facilities, shopping centres, etc., yet within easy reach of the many attractions of Canada's largest and most interesting city.

Please send complete résumé to:

W. J. Riley, Chief Engineer
Sperry Gyroscope Company of Canada, Ltd.
P.O. Box 710 — Montreal, Que.

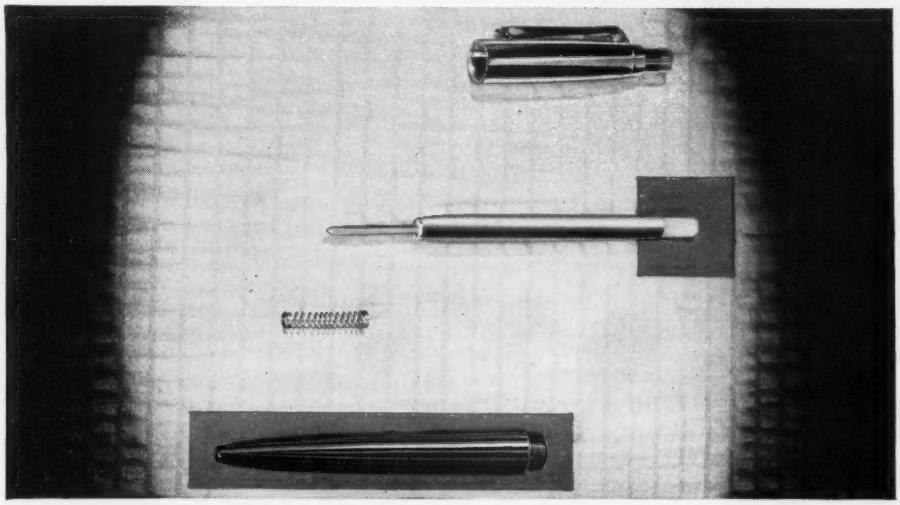
DUPONT CANADA

PRODUCT ENGINEERING NEWS

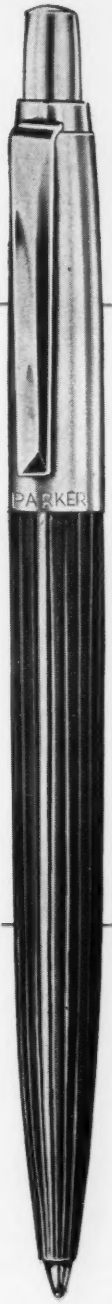
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

PARKER 'Jotter' DEPENDS ON 'ZYTEL' NYLON

Precision moulding of mechanical parts of new ball-point type pen insures long life at minimum cost.



"Zytel" nylon resin barrel and ratchet provide toughness, smooth working, and long wearing characteristics to the vulnerable working parts of this unique ball-point pen, made in Canada by Parker Pen Co. Ltd., Toronto.



The Parker Pen Co. has long had the reputation of building only the highest quality of mechanical pens and pencils. Their decision to add a "ball point" to their line was made only after they were satisfied that they could produce something in this highly competitive field that would measure up to the exacting standards they have always set for themselves. "Zytel" nylon was a natural choice for two parts.

The unique feature of this design is a mechanism which permits the protrusion and retraction of the point by movement of a single plunger located at the end of the pen. To accomplish this, a small ratchet was needed which would revolve the entire stem, thus positioning it for the next stroke of the plunger, permitting alternate protrusion and retraction of the point. To machine such a part from a metal having the required wear-resistant qualities would be prohibitively expensive. To mould it from nylon was inexpensive and at the same time, solved what might have been a serious lubrication problem.

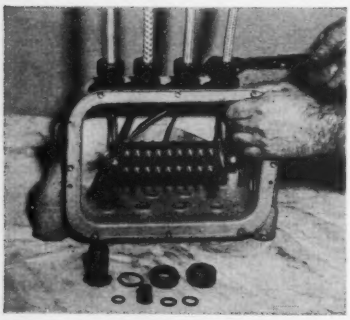
"Zytel" nylon resin was also chosen for the barrel to provide the toughness and long life needed to match these qualities in the working parts. Light weight but strong, the "Zytel" barrel is unaffected by oils, moisture or other substances which might mar a lesser material.

DU PONT CANADA

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Conduit fittings of ZYTEL* are economical, reduce galvanic corrosion



Installing a conduit fitting molded of "Zytel". Note component parts in foreground. A neoprene grommet incorporated in design enables 9 sizes of these fittings to do the job of 27 sizes of former metal fittings. Parts of "Zytel" molded by Danielson Manufacturing Company, Danielson, Connecticut.

ENGINEERS are finding new ways to simplify design and reduce costs by substituting parts of "Zytel" nylon resin for parts of metal or other conventional materials. An outstanding example of a more efficient design is this new conduit fitting used by the U. S. Navy to form a tight seal where cables enter terminal boxes.

As replacements for traditional fittings of metal, the parts molded of "Zytel" offer a saving of 80% in weight. (This amounts to 30-45 tons on an aircraft carrier.) The nylon fittings are less expensive to produce, easier to handle. And, because of the improved design of the new fittings, 9 sizes do the job of 27 sizes of the old. The Navy estimates a saving of $31,000 on a typical ship with fittings of "Zytel".

"ZYTEL" also offers mechanical advantages

"Zytel" is not subject to salt-water and galvanic corrosion, a frequent source of trouble with metal fittings aboard ship. Its high impact strength and resistance to heat and abrasion are other important advantages in electrical applications. *You* may have a product or process that will be improved by utilizing the properties of molded Du Pont "Zytel" nylon resin. Clip and mail the coupon for further information.

Investigate Du Pont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design. The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION? Clip the coupon for additional data on the properties and application of these Du Pont engineering materials.

DU PONT COMPANY OF CANADA LIMITED,
CHEMICALS DEPARTMENT, Room A-4, P.O. Box 660, MONTREAL, QUE. DE2

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME_____ POSITION_____

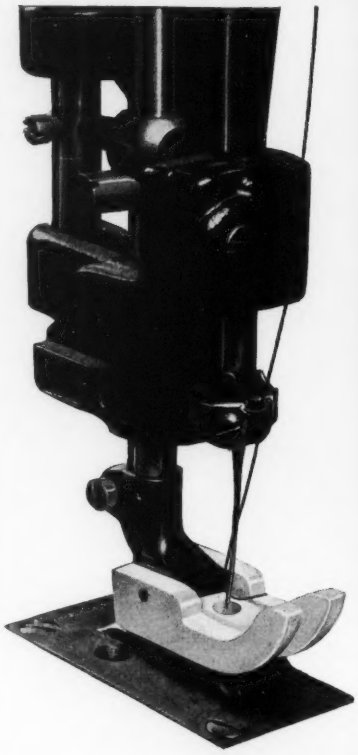
COMPANY_____

STREET_____

CITY_____ PROVINCE_____

TYPE OF BUSINESS_____

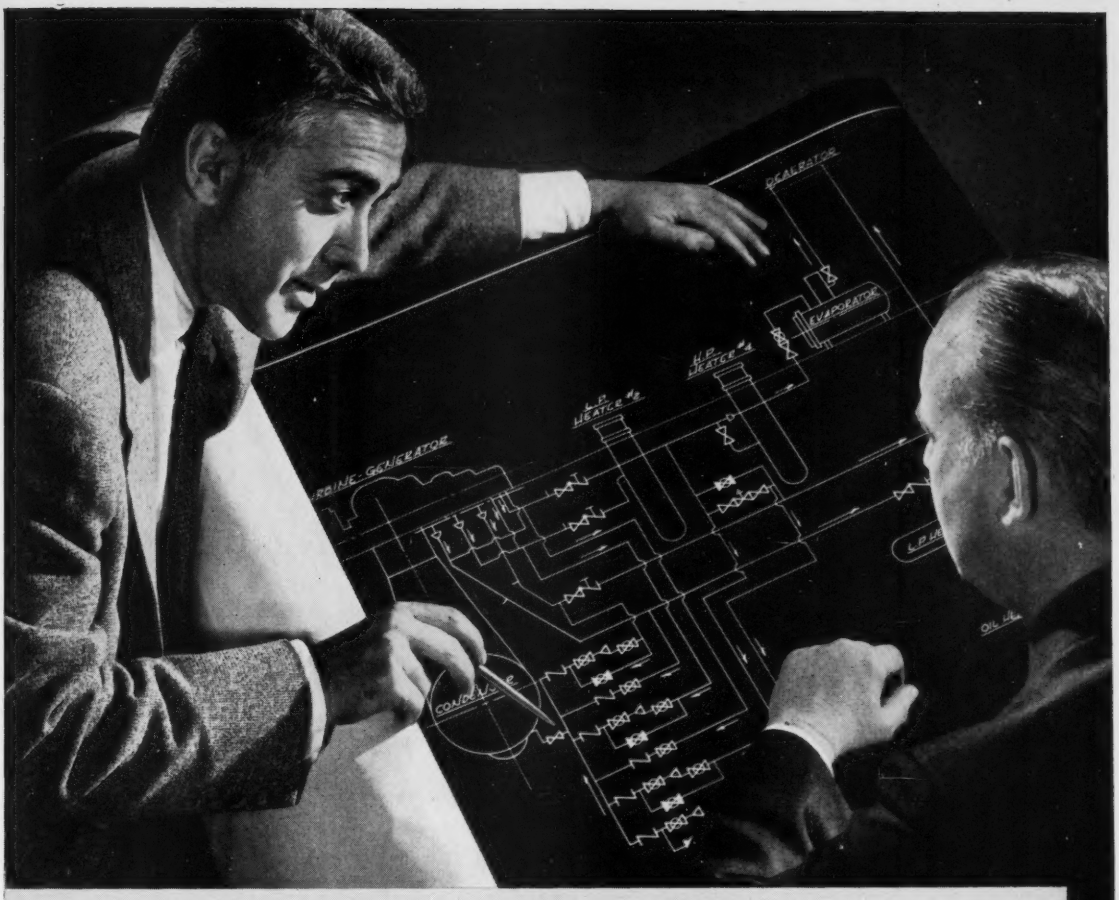
*"Alathon" "Lucite" "Teflon" and "Zytel" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)



Smooth, low-friction surface of TEFLON* improves presser foot operation.

THIS presser foot, used on industrial sewing machines, is now molded of "TEFLON" tetrafluoroethylene resin. The foot guides material as it goes under the needle. The machine is designed primarily for sewing difficult materials such as rubberized fabrics. "TEFLON" has a low-friction surface which improves the mechanical operation of the sewing machine and eliminates need for a walking foot mechanism. (Manufactured by the Chase Sales Company, Hayward, California.)

For complete details on this outstanding Du Pont engineering material, mail the coupon at left.



X-thousand chances to be wrong...or right!

IT'S HERE when piping is in the blueprint stage that both original costs and operating costs are determined. Make the wrong choice—an inferior valve—for just one location and it may mean only *a little extra* maintenance later on. But if "wrong" valves are specified at a dozen, a score —or more—locations, the *added* cost for excessive maintenance can become hard to take . . . especially when many a valve failure can disrupt an entire plant operation.

You can avoid trouble and wastefully high maintenance by discerning purchase of valves and fittings of greater suitability, greater dependability. Quality becomes the important specification. That's why it's thrifty buying to depend on the consistent quality of the broad Crane line.

For complete information—see your Crane Catalogue or get in touch with your Crane representative, Crane Branch, or

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CRANE VALVES • FITTINGS • PIPING PLUMBING • HEATING

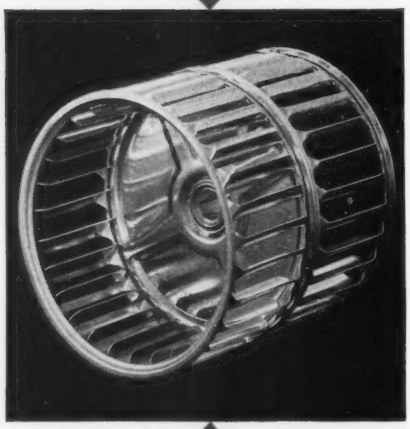
NATION-WIDE SERVICE THROUGH BRANCHES, WHOLESALERS and PLUMBING AND HEATING CONTRACTORS

Quiet Operation
High Air Delivery
Uniform Construction

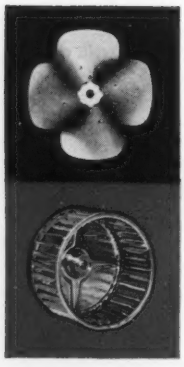
...that's why manufacturers

specify Torrington AIRotors

Torrington AIRotor blower wheels are available in three general categories: single wheel, double wheel, (illustrated) and the "X Type" double inlet wheel. Sizes range from 1½" in diameter and ⅝" in width to 11" in diameter and 11$\frac{13}{16}$" in width. Special spline, jaw, or short hubs are also available.



Torrington Airotors represent only a small portion of the unusually broad variety of air-impellers which Torrington is currently equipped to produce for heating, ventilating and air-conditioning equipment. This product range, plus Torrington's great capacity, can provide... quickly and at low cost... the fan blade or blower wheel that's best suited to your air-moving requirements. Torrington also maintains a complete research testing service for assistance on any design problem relating to air flow, sound and vibration. This service is always available to you and can be of particular value in the early stages of product design and development. No one has more experience in the design and production of air-impellers than Torrington. Nowhere else can your dollar buy so much in terms of product quality and customer service.



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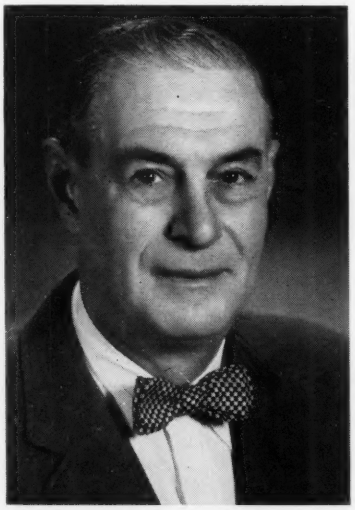
VIP's

Important people who are in the news

AN ARDENT sportsman who has a penchant for outdoor life has been elected president of the 14,000-member Association of Professional Engineers of Ontario.

When **Merrit Windes Hotchkin, P.Eng.,** assumed his presidential duties on January 1, he nonetheless entered the office well fortified to cope with problems that arise behind the desk as well as in the field, since he has held many executive jobs. He is currently associated with Wright-Hargreaves Mines Ltd., as engineer in charge of outside explorations, and resides in Kirkland Lake with his wife. He has two married children.

Born in Chicago near the turn of the century, engineer Hotchkin was capably versed in practical mining even before



MERRIT HOTCHKIN
APEO president for 1956

graduation from the Michigan School of Mining and Technology in 1908. The experience was acquired in the milling and mining industry in the Western U. S. and Alaska.

Engineering work followed at the Tough Oakes Gold Mines Ltd., owned by the late Sir Harry Oakes and his associates. Soon engineer Hotchkin was manager. Just after the outbreak of World War I when the rich surface vein systems were cut off by extensive north and south faulting in the rock, production ceased.

His postwar career took him back into mining and he carried out base metals exploration for himself in Canada, the U. S. and Mexico.

Result: Within a year, after exhaustive examination and detailed underground geological mapping, Hotchkin located the faulted part of the high grade ore body—which turned out to be one of Canada's richest gold veins.

Closed down in 1953 after operating for 21 years, Toburn Gold Mines Ltd., with engineer Hotchkin as general manager had produced $15 millions.

The Association of Professional Engineers of Ontario which has a permanent staff of 17 will see its membership grow by some thousand more engineers through 1956, estimates Colonel J. M. Muir, association secretary-treasurer and registrar.

"President Hotchkin faces a busy year," he commented. "It will be part of his duties to sign new members certificates, address meetings of engineers and act as key man in setting matters of policy of our expanding association."

But collective though his duties may be, President Hotchkin should be suitably groomed—he was 1st vice-president last year—for his role in 1956.

Also named to the new executive were John H. Fox, general sales manager, Minneapolis-Honeywell Regulator Co. Ltd., Toronto, as 1st vice-president, and C. T. Carson, vice-president and production manager, Hiram Walker & Sons Ltd., Walkerville.

Serving on Council during the year will be two representatives from each of the five branches of engineering. They are:

Civil Branch: Tullis N. Carter, Toronto, vice-pres. and general manager, Carter Construction Co., and Joseph H. Irvine, Ottawa, of James F. MacLaren Associates.

Chemical and Metallurgical Branch: Gordon W. Ames, Sarnia, senior design engineer, Polymer Corp. Ltd., and Patrick E. Cavanagh, director, engineering and metallurgy, Ontario Research Foundation, Toronto.

Electrical Branch: John W. Holmes, design engineer, Canadian General Electric Co. Ltd., Peterborough, and John W. Waghorne, engineer-in-charge, electrical research dept., Ontario Hydro-Electric Power Commission.

Mechanical, Aeronautical and Industrial Branch: John H. Ross, Toronto, consulting engineer; and William D. Sheldon, Jr., president and chief engineer, Sheldons Engineering Ltd., Galt.

Mining Branch: M. S. Fotheringham, president and general manager, Steep Rock Iron Mines Ltd., Steep Rock, Ont., and Charles P. Jenney, chief geologist, The American Metal Co. Ltd., Toronto.

The Association's permanent officers are: T. M. Medland, executive director; Colonel J. M. Muir, secretary-treasurer and registrar; and T. C. Keefer, field secretary of the Association.

• • •

ONE OF CANADA'S contributions to the International Geophysical Year which starts in 1957 will be the Auroral Recorder, which measures the light intensity of the Aurora Borealis or Northern Lights.

Roy L. Adams, 39-year-old former general manager and design engineer at the Toronto firm of the McPhar Manufacturing and Engineering companies

ROY ADAMS
PSC's production co-ordinator

will supervise production engineering on the Canadian project at PSC Applied Research Ltd., where he is now production co-ordinator. He will also be responsible for the engineering design on the company's own Airborne Profile Recorder, used for aerial survey.

Design Engineer Adams was a matriculant of Danforth Technical School and an electrical engineering graduate of Toronto University.

A member of the Professional Engineers of Ontario, co-ordinator Adams is also a senior member of the Institute of Radio Engineers. He is a radio "ham" and operates an amateur radio station with the call letters VE3AMR from his Don Mills home.

Engineer Adams is married and has three children. In addition to his radio hobby, the Toronto-born supervisor of the Auroral Recorder is a director of the East York Rotary Club. A long-time photography enthusiast, he finds his accumulated darkroom knowledge helpful on the PSC Applied Research team.

Design Engineering

Glass is what you want to make it

By JOHN G. LANNING

CORNING GLASS WORKS

Glass is 5,000 years old — and still new. Now more than 450 types are made for use in countless different precision products of today

OUT OF GLASS test tubes come many strange materials for the use of modern man. None is stranger, none more a "wonder" material, than glass itself.

It has been melted and used for over 5,000 years —yet always offers something new. During 1954, about 14 billion pounds of glass were pressed, rolled, blown and drawn into products worth over $1.6 billions. This is a bigger poundage than all plastic, synthetic rubber, aluminum, copper and lead products combined. And, as glass grows in industrial stature, so it grows in usefulness. The day may come when it will be quicker to list what cannot be successfully made of glass than what can. Such is the story of an art-come-technology which links the Pharaoh-times Egyptian to the modern man of science.

In the early days, glass making techniques were crude and the chemistry of the process was little understood.

Now there are countless glass formulas evolved and tested which replace the old hope-for-the-best methods with a new engineering precision. Corning Glass Works, for instance, has 80,000 glass formulas on its files; it melts some 450 types of glass per year; and it manufactures more than 40,000 glass products.

Glass is versatile. Even taking the many demands modern products have to meet into account (accurate size, appearance, tough working conditions, performance, cost limits and so on) it is seldom beaten.

Among the thousands of glass formulas are some which give it lightness and some which give it weight —almost as much weight as iron. Foam glass, for instance, can have a density less than cork; yet radiation shielding glass is nearly as heavy as iron.

Then some has a softening (melting) temperature higher than steel; some has one lower than lead. It can have a mechanical strength greater than cast iron —or it can be controlled for any specific fragility. The thermal expansion of glass can be above that of steel; or it can be as low as that of quartz.

Transmission and absorption of the spectrum can be widely controlled and the electrical properties can be greatly varied. The various characteristics of some important glasses are listed (see table).

Glass can be divided into five types: Mechanical, electrical, chemical, thermal and optical. Mechanically, a perfect piece of glass is unbelievably strong, having an intrinsic strength of 3×10^8 psi. Glass

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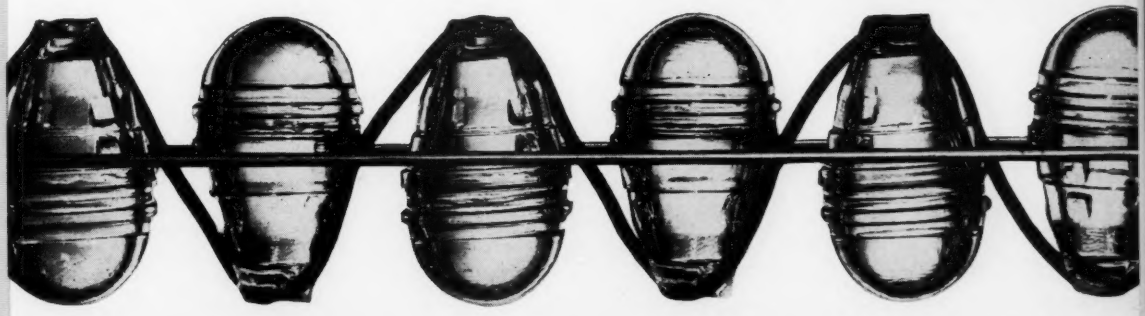
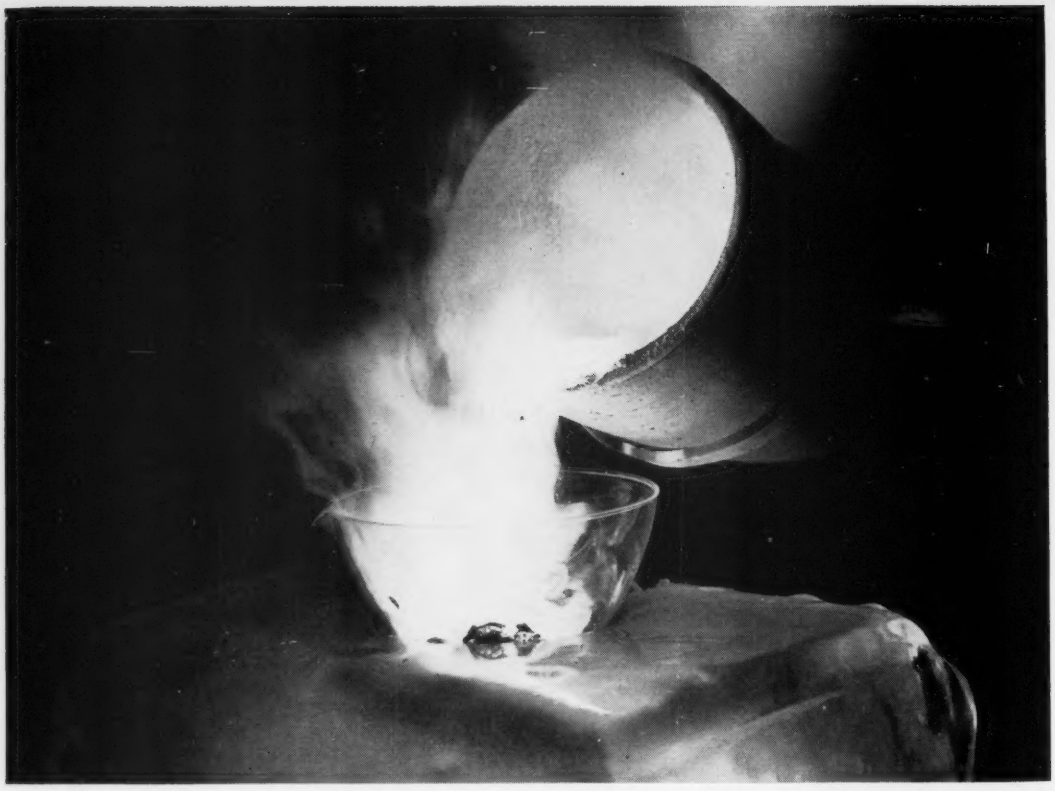


Charges to perforate oil well casings are protected by glass containers which disintegrate into a fine powder.



Vycor 96 per cent silica glass dish on ice will not melt, crack or deteriorate as molten metal is poured.

What is glass?

Glass is an amorphous or non-crystalline material that is rigid at ordinary temperatures and soft or almost fluid at elevated temperatures, with no definite melting point in between.

The principal constituent of most glasses is sand, or silica (SiO_2). It might often be the only ingredient if it could be melted more easily. But sand alone cannot be melted at reasonable cost so various fluxes are mixed with it to lower the fusion point.

Soda lime glasses (or lime glasses) used for envelopes, bottles and window glass are melted from silica that has been fluxed with lime and soda plus small quantities of other oxides.

Lead glasses, which contain lead oxide, are used for electric light bulb stems, neon sign tubing, crystal tableware and as shields to cut off X-ray radiation.

Borosilicate glasses have boron oxide as an ingredient and are used for chemical laboratory glassware, boiler gauge glasses and glass pipe.

Lime, lead and borosilicate glasses can all be colored by the addition of metallic oxides that become suspended or dissolved in the parent glass without substantially changing its chemical composition or physical properties.

Glass in design *(Continued)*

fibres can carry a tensile stress greater than 1 x 10^6 psi. But, due to the surface imperfections, the everyday strength of glass is only a small fraction of this.

A brittle material (like other ceramics) glass does not deform plastically before failure and fractures only in tension—never in shear or compression. To understand this the theory of glass failure must be known. A glass failure originates in small flaws or cracks, often invisible even under a microscope, found in the surface of the glass.

The extreme narrowness of these flaws causes a stress concentration under tension which may be many times the nominal stress at the same point. Metals can yield at this point of concentration to relieve and equalize the stresses. But glass has no yield—and failure occurs. Compressive surface stress tends only to close these small flaws or cracks.

Other valuable mechanical properties are:

Smoothness: Glass is essentially a sub-cooled liquid at operating temperatures so that its surfaces are smoother than the molds from which the article is produced.

Hardness: The hardness of glass is usually evaluated by scratch tests or impact abrasion tests. Agate, sand, carborundum, hard steel and emery are hard enough to scratch glass. Mica, mild steel, copper, aluminum and marble cannot.

Permanence of shape: There is almost no mechanical hysteresis in glass; it can be assumed that glass is per-

fectly elastic right up to the point where it fractures.

The electrical insulating qualities of the material have led to its use in insulators, incandescent lamps, neon sign tubing, sealing beads and electronic tube components. Electrical glasses have a high dielectric strength (3,100 to 500 kv/cm at room temperature), high volume resistivity (about 10^{12} to 10^{16} ohm/cm), both high and low dielectric constants, depending upon the type of glass, and excellent nontracking properties. Several glass compositions are available with loss factors lower than 0.0025 (1 mc at 20 C).

Glass has one outstanding chemical property; its resistance to corrosion. Hydrofluoric acid, hot concentrated phosphoric acid, certain alkaline solutions and superheated water are the only reagents known to attack glass. Borosilicate glasses, such as the Pyrex range, are known to resist corrosion from all other atmospheres and chemicals even at elevated temperatures.

Thermally, special glasses such as Pyrex brand, and especially Vycor brand 96% silica glasses, can stand up to sudden extreme thermal shock without fracturing. While possessing low thermal conductivity (about 2% that of iron) glass also expands at a rate less than steel, making it an ideal material for laboratory and kitchen ware. Glasses also effectively transmit heat radiation from incandescent tungsten filaments and similar sources.

Some glass passes infra-red

The optical properties of glass are of the greatest value to industries where transmission, refraction or absorption of light rays is essential. Some glass can pass infra-red waves as high as 4.5 microns,* while others will transmit light in the ultra-violet region having wave lengths as low as 0.22 microns. Most glasses give high transmission of electromagnetic energy within the range of the visible spectrum.

Once known and understood, the properties of glass may be applied to the design of countless products. The rise within the past 20 years of electronic industries, for instance, has precipitated a large growth of engineered glass products; among them: capacitors, resistors, glass insulating beads of various shapes (multiform), radar tube jackets, metallized tubes, relay enclosures, and photosensitive glass, which can reproduce exactly any photographic pattern, no matter how intricate.

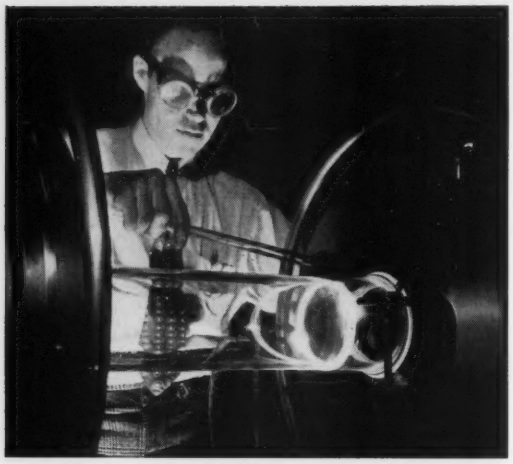
Television, which overnight grew from a pampered baby to an industrial giant, required the development of a glass picture tube which enabled the viewer to see the picture and which, in addition, provided excellent electrical insulation. The small picture tubes for television sets of 1946 were made by conventional molding methods and gas sealing techniques. The demand for larger and larger tubes increased the molding problems while the greater thickness required for the external test pressure made gas sealing nearly impossible.

The problems were solved by making use of a unique property of glass. Glass engineers knew that although glass is an excellent electrical insulator, its volume resistivity decreases rapidly with temperature rise until, near the melting point, the glass will freely conduct electricity. This permitted the application of electrical sealing methods and the sealing of the larger, heavier bulbs became possible. By these new methods, a 27-in. rectangular bulb faceplate weighing nearly 30 lb., is pressed automatically, and electrically sealed to a glass funnel. (See also **Design Engineering,** December 1955.)

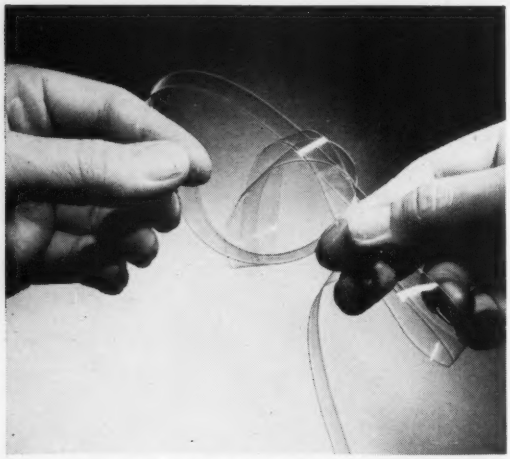
(cont'd)

*A micron is equal to one-millionth of a metre.

Master "gaffer" lowers gob into mold, then blows, twirls glass on blow-iron end until huge cylinder forms, which in special cases can only be made up this way.



Electronic cross-fire sealing lathe guns weld pipe after ends have been preheated to conduct electricity.



Glass ribbon has electrical properties of high-grade mica, is one-thousandth in. thick, can roll or twist.

Test cell wall radiation-shielding window is 36 in. thick, is made of four glass castings stacked, above. Glass is extremely heavy, some with density of iron.

Glass in design *(Continued)*

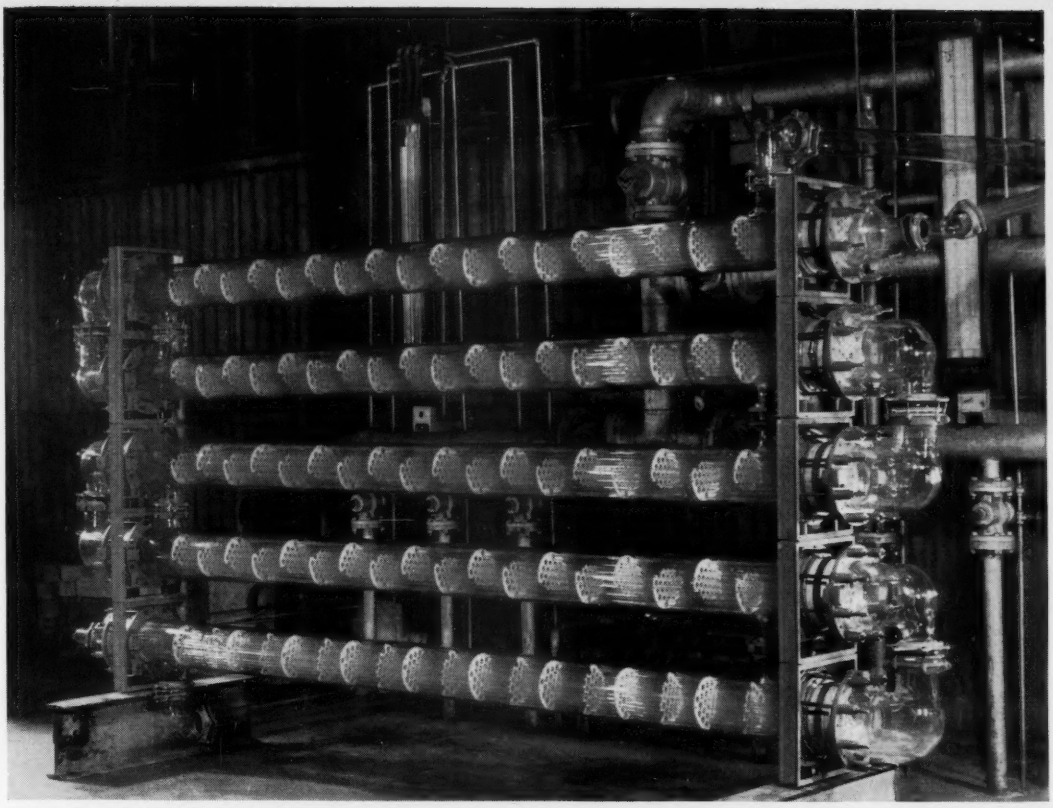
Engineers found that glass, with its high electrical resistance, high dielectric constant and low power factor, would be extremely suitable as the dielectric in a capacitor. The glass is drawn into flexible ribbons, as thin as 0.001 in., and laminated with thin layers of aluminum, the overhanging edges of which are sealed together. As a result of the high dielectric constant plus the thinness and uniformity of the ribbon, the resulting capacitors are generally smaller in size and weight than other capacitors giving comparable performance. By enclosing the capacitor in a case of the same glass, an electrical element independent of atmospheric conditions was produced. The glass capacitor is temperature stable and capacitance drift is very near zero.

Metal oxide coatings can be bonded to glass to form electrically conducting films which adhere tightly to the glass surface. Produced to specific resistances, this glass forms the highest temperature film-type resistors available. The thin film makes them frequently insensitive and non-inductive. They are tough enough to be heated to incandescence with no physical or electrical change. Because of the low expansion of the glass body the thermal shock resistance of such a resistor is excellent. The durability of the film and glass body is such that the resistor can be placed across an electrical bridge and scraped with a steel scale, or swished about in nearly all acids, with virtually no change in electrical performance when placed back in operation.

Along with the expansion of electronic industries has come increases in nearly all phases of the process industry. New chemicals, plastics and resins mean new problems in corrosion and in handling corrosive fluids. Where corrosion exists, glass often appears as the answer.

Glass piping was developed to answer the need for corrosion-resistant conveying lines with extremely low thermal expansion. The pipe is joined in sections by special flanges which keep the glass under compression. To provide a more complete answer to corrosion problems, engineers have developed glass process equipment such as distillation columns, valves, shell and tube heaters and heat exchangers, cascade heat exchangers and bubble cap columns. Providing the temperature and pressure recommendations are observed this glass equipment is recommended for all process applications except those involving hydrofluoric acid, hot or concentrated phosphoric acid and hot or concentrated alkalies.

Expanding process industries demand more oil, and more oil means more wells and greater production quotas from each well. Oil is seldom obtained by tapping the oil dome and pumping it out. The well is drilled through an oil-bearing strata, which must then be broken up or perforated to provide an adequate flow of oil into the well. Producing wells must be reperforated when the flow channels become plugged. One way to perforate this oil strata is to produce as long a hole as possible through the casing and into the oil bearing strata. This can be done by several methods but for long, clean penetration, a shaped charge produces excellent results. However, if the case which carries this charge is not pulverized as the charge is exploded, it leaves large particles of material that eventually plug the pumping orifices of the well. Engineers developed a glass case to carry the charge which left nothing but a residue re-



Shell, tube heat exchanger are mounted horizontally, series-connected as cooler, condenser, heat exchanger.

Appliance designers use glass for everything from fuses to heating panels

sembling fine white sand after the explosion. Pressure in a deep well can reach 20,000 psi, but since it is applied to the glass externally, the glass is held under compression and the case will function at pressures as high as 40,000 psi.

Nor has the glass engineer limited himself to designing products strictly for industries. The American homemaker has benefitted through innumerable uses of glass in the home. The design engineer, taking advantage of the low thermal expansion, electrical resistance, high melting point and complete visibility of glass, has fashioned everything from heat-resistant oven windows to tough mixing bowls of glass, from tempered glass cooking vessels to the threaded and knurled glass fuse for domestic use.

Electric appliances in the home have increased fourfold in the past 10 years. Similarly, the use of glass in electrical appliances has increased. Engineers were aware that glass, while having relatively poor thermal conductivity, possesses excellent radiant heat transmitting qualities. By using the glass resistor principle and applying it to a sheet of low expansion flat glass, an electrically conducting, or E-C glass was produced. The Pyrex brand E-C panel, coated with a thin film (1/16 millionths of an inch) of metallic oxide, emits most of its radiant energy from the entire surface of the non-coated side. A metal reflector in back of the coated side increases radiant efficiency to as much as 80% and makes a unit which is electrically safe for children with inquisitive fingers. Use of low expansion glass removes the possibility of the glass panel failing when a wet rag is wiped across its hot surface. The entire unit, set in a metal frame and recessed into the wall.

In the kitchen, glass comes steadily forward. The glass design engineer, seeking for ways to add eye appeal through glass in the kitchen, has come up with pastel-shaded mixing bowls, permanently colored dishware and, lately, a self-contained cooking unit to do away with unsightly black coils in electric stoves. This new glass unit makes use of Vycor brand 96% silica glass to bring the housewife a heat-resistant, neat looking and easily cleaned top-of-stove cooking unit. Wires, pressed tightly against the underside of the silica glass, act as the heating element, and the glass acts as a distributor of the heat.

Coffee urn liners, drink mixer jars, diffused lighting panels, broiler trays for ranges, vacuum coffee-makers, washing machine windows, induction furnace linings, bulbs for ultra-violet lamps, heavy gauge glasses, lightning arrester bodies, baster tubes for cooking, vacuum bottle blanks—these are but a few of the designs in glass that engineers have successfully turned out. Glass noses for supersonic rockets to withstand rain erosion at immense speeds, cooking in glass in radar heated ranges—these are a few of the problems that design engineers are currently dealing with. It is anybody's guess what this old "wonder" material will be doing for us 100 years hence. Glass certainly has not finished growing yet. ★

An open approach to combined stresses

By WILLIAM MORSE, P.Eng.
ENGINEERING EDITOR

In this excerpt from lectures by the author on strength of materials, principal stresses not understood, are given a straightforward treatment

Combined Shear and Tension

CONSIDER a block $ABCD$, of unit depth into the paper, acted on by shear stresses and complementary shear stresses $\tau = 17{,}000$ psi. and a tensile stress $\sigma = 40{,}000$ psi. (PICTURE 1).

It is instructive to consider the general effect of the combined stresses on some plane CE inclined to BC at an angle $\theta = 35°$, say, chosen at random.

Forces acting on plane *EC* (PICTURE 2)

Consider wedge EBC (PICTURE 2a)

Shear load on $EB = \tau EB = 17000 \times 1.2 = 20400$ lb.

Shear load on $BC = \tau BC = 17000 \times 1.7 = 28900$lb.

Tensile load on BC, $P = \sigma BC = 40000 \times 1.7 = 68000$ lb.

The shear loads on EB and BC can be compounded vectorially at B to give a resultant $R_1 = 36000$ lb. (PICTURE 2b). Resultant R_2 of R_1 and the tensile load P on BC can then be compounded vectorially to give a resultant shear load $R_2 = 96000$ lb. inclined at some angle α to EC and having a component shear load $R_2 \sin \alpha$ normal to EC and a component shear load $R_2 \cos \alpha$ tangential to EC, acting from E to C.

It will be clear that since for plane BC ($\theta = 0$) the shear stress τ acts from C to B and for plane EC ($\theta = 35°$) the shear stress $f_s = \dfrac{R_2 \cos \alpha}{EC}$ acts from E to C, by suitable choosing θ to have an intermediate value, denoted as $\theta_N = 20°12'$, it is possible, as in Picture 3, to obtain the condition whereby $R_2 = 83500$ lb. is normal to EC and its tangential (or shear) component $R_2 \cos \alpha$ along EC is zero.

In other words, the resultant stress f_N on plane EC is wholly a normal stress.

Under these conditions, normal stress on EC due to R_2 is:—

$$f_N = \frac{83500}{EC} = \frac{83500}{1.8} = 46300 \text{ psi. (tension)}$$

Principal planes and principal stresses

Planes through a point in a material such that the resultant stress across them is wholly a normal stress (tension or compression) are called Principal Planes and the normal stresses on them are the Principal Stresses at that point.

Through any point there are two principal planes and two principal stresses. The Major principal plane, for the case just dealt with, is EC (PICTURE 3) inclined at $\theta_N = 20°21'$ to BC and the Major principal stress is $f_N = 46300$ psi. (tension) normal to EC.

The Minor principal plane is BF (PICTURE 4) inclined at 90° to EC and hence at $\theta_N' = 90° + \theta_N = 90° + 20°12' = 110°12'$ to the vertical.

Using in PICTURE 4 a similar construction to that in PICTURE 3, shear load in

$FC = 17000 \times 4.62 = 78600$ lb.

$BC = 17000 \times 1.7 = 28900$ lb.

Tensile load in BC, $P = 40000 \times 1.7 = 68000$ lb. Find the resultant R_1 of 78600 lb. and 28900 lb. and compound $R_1 = 84000$ lb. and P to give $R_2 = -31000$ lb. (compression) acting at 90° to BF.

Minor principal direct stress

$$f_N' = \frac{R_2}{BF} = \frac{-31000}{4.94}$$

$= -6300$ psi. (compression)

Formulas for principal stresses

It can be shown that if σ is the tensile stress (acting on block $ABCD$) and τ is the shear stress:

Major principal direct stress

$$f_N = \frac{\sigma}{2} + \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$$

For the particular case above, $\sigma = 40000$ psi. and $\tau = 17000$ psi.

$$f_N = 20{,}000 + 10^3\sqrt{20^2 + 17^2}$$

$= 20{,}000 + 26{,}300$

$= 46{,}300$ psi. (tension) as obtained in Picture 3.

Minor principal direct stress

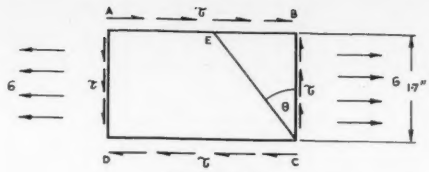
$$f_N' = \frac{\sigma}{2} - \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$$

$= 20000 - 26300$

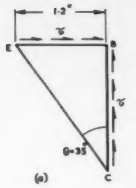
$= -6300$ psi. (compression), as obtained in PICTURE 4.

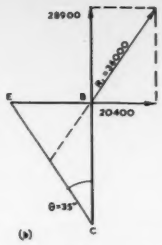
Direction of principal planes

Angle θ_N of the major principal axis (PICTURE 3) is given by:—

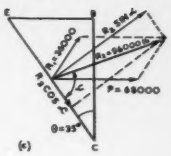


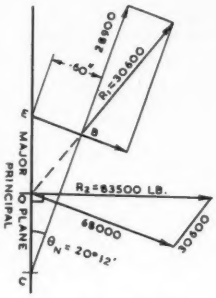
Picture 1.



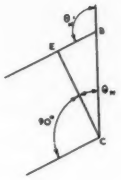


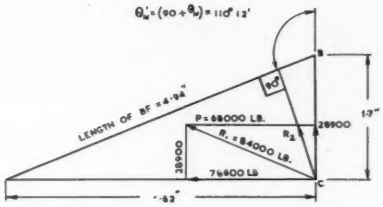
Picture 2.



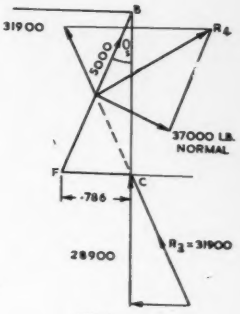


Picture 3





Picture 4



Picture 5

$$\text{Tan } 2\theta_N = \frac{2\tau}{\sigma} = \frac{17000}{20000} = .85$$

$$2\theta_N = 40°24'$$

$$\theta_N = 20°12'$$

Angle $\theta_N{}^1$ of minor principal axis (PICTURE 4)
$= (90° + \theta_N)$
$= (90° + 20°12')$
$= 110°12'$ to vertical.

Maximum shear stress

In a similar manner, consider a plane such as BF in PICTURE 5, inclined to BC at an angle $\theta_S = 24°51'$, so chosen because, as shown below, it gives the maximum shear stress f_s on BF. (Note that θ_S is not the same as θ_N)

Shear load on FC $= \tau FC = 17000 \times .786$
$= 13360$ lb.

Shear load on BC $= \tau BC = 17000 \times 1.7$
$= 28900$ lb.

Tensile load on BC, P $= \sigma BC = 40000 \times 1.7$
$= 68000$ lb.

The shear loads on FC and BC can be compounded vectorially at C to give $R_3 = 31900$ lb. The resultant of R_3 and the tensile load P on BC give a resultant R_4 which can be resolved into a normal force = 37000 lb. and a tangential force (shear) of 50000 lb.

$$\text{Shear stress on } BF = \frac{50000}{BF} = \frac{50000}{1.9} = 26300 \text{ psi.}$$

Mathematically, max. shear stress

$$= \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$$

$= 26300$ psi. from an earlier section.

This acts at

$$\cos 2\theta_s = \frac{\tau}{\sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}} = \frac{17000}{26300} = .647$$

$$2\theta_s = 49°42'$$

$$\theta_s = 24°51'$$

It is useful to remember that the max. shear stress always occurs on a plane at 45° to the major principal direct stress. That is $\theta_N + \theta_S = 45°$
In this example, $20°12 + 24°51 = 45°03'$

Special Cases

(**a**) When applied shear stress is zero (PICTURE 6).

Continued over page

Major principal direct stress

$$f_N = \frac{\sigma}{2} + \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$$

$$= \frac{\sigma}{2} + \frac{\sigma}{2} = \sigma \text{ (tension)}$$

$$\text{Tan } 2\theta_N = \frac{2\tau}{\sigma} = 0$$

$$\theta_N = 0$$

Hence principal plane is BC at right angles to the applied tensile stress (as would be expected).

Max. shear stress.

$$f_S = \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2} = \frac{\sigma}{2}$$

$$\cos 2\theta_S = \sqrt{\frac{\tau}{\left(\frac{\sigma}{2}\right)^2 + \tau^2}}$$

$$2\theta_S = 90°$$

$$\theta_S = 45°$$

Hence max. shear stress. $f_S = \frac{\sigma}{2}$ occurs on a plane at 45° to the applied tensile stress σ and also, of course, at 45° to f_N, in the usual manner.

If the allowable shear stress of a material is less than half the allowable tensile (or compression) stress, fracture will take place in shear at 45° to the axis of the applied tensile (compressive) load.

(**b**) When applied tensile stress is zero (PICTURE 7)

Major principal direct stress

$$f_N = \frac{\sigma}{2} + \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2} = \tau$$

$$\text{Tan } 2\theta_N = \frac{2\tau}{\sigma} = \infty \text{ (infinity)}$$

$$2\theta_N = 90°$$

$$\theta_N = 45°$$

Minor principal direct stress =

$$\theta_N{}^1 = 90 + \theta_N = 135° \text{ to vertical}$$

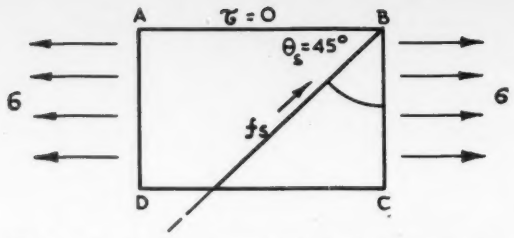
Numerical Example No. 1 Combined Bending and Shear

To find the major principal direct stress and the max. shear stress at Sections 44, 33, 22, 11 and XX of the rectangular beam shown in PICTURE 8 under the action of a vertical shear V = 100,000 lb. and a bending moment M = 426,000 lb. in.

The distribution of shear stress τ due to V is in accordance with the values given in the Table below:

$$Z = \frac{bd^2}{6} = \frac{1.0 \times 64}{6} = 10.67 \text{ in}^3.$$

Bending stress at extreme fibre $\sigma = \frac{M}{Z} = \frac{426{,}000}{10.67} = 40{,}000$ psi.



Picture 6. Special case. Applied shear stress zero, principal plane at 45 deg. to applied tensile stress.

Values of σ at other stations are given in Table 1. Note that the max. shear stress on the section occurs (in this example) at the extreme fibre (at $\theta_s = 45°$) due to the fact that $\sigma/2$ there is greater than τ at XX.

Numerical example No. 2 bending and torsion combined

PICTURE 9 shows a bar of diameter 1 in., built-in at one end and free at the other. A wire is wound round the last inch of the bar and vertical loads of 2000 lb. are applied at each end of the wire.

Find the max. principal stress and max. shear stress for the material of the unwound part of the bar. (AFRAeS)

Torque $T = 2000 \times 1.0 = 2000$ lb. in., constant over the whole length.

Max. B.M. will be constant between the built-in end and the inboard load of 2000 lb.

Root B.M. due to up load

$= 2000 \times 3.7 = 7400$ lb. in.

Root B.M. due to down load

$= 2000 \times 2.7 = 5400$ lb. in.

Nett B.M. 2000 lb. in.

$$Z = \frac{\pi}{32} D^3 = .0981 \text{ in}^3.$$

$$\text{Bending Stress} = \frac{M}{Z} = \frac{2000}{.0981} = 20350 \text{ psi.}$$

Shear stress due to Torque

$$\tau = \frac{T}{2Z} = \frac{2000}{.1962}$$

$$= 10175 \text{ psi.}$$

Max. principal direct stress

$$= \frac{\sigma}{2} + \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$$

$$= 10175 + 10^3 \sqrt{10.175^2 + 10.175^2}$$

$$= 10175 + 10175\sqrt{2}$$

$$= 24575 \text{ psi.}$$

Max. shear stress

$$= 10175\sqrt{2} = 14{,}400 \text{ psi.}$$

Bending of tube in two planes

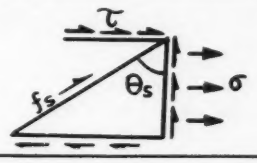
For a completely symmetrical section, like a

Continued over page

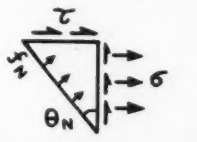
Station	τ	$\tau^2 \times 10^{-6}$	σ	$\sigma/2$	$(\sigma/2)^2 \times 10^{-6}$	$\left[\left(\frac{\sigma}{2}\right)^2 + \tau^2\right]10^{-6}$
44	0	0	40,000	20,000	400	400
33	8200	67.2	30,000	15,000	225	292
22	14100	198	20,000	10,000	100	298
11	17600	309	10,000	5,000	25	334
XX	18750	350	0	0	0	0

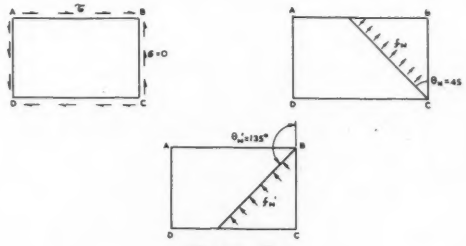
$$f_S = \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2} = X \text{ say, for convenience.}$$

Station	$f_S = X$	$\cos 2\theta_S = \frac{\tau}{X}$	$2\theta_s$	θ_s	Key diagram
44	20000	0	90°	45°	
33	17100	.479	61° 24′	30° 42′	
22	17300	.816	35° 18′	17° 39′	
11	18300	.962	15° 48′	7° 54′	
XX	18700	1.0	0	0	

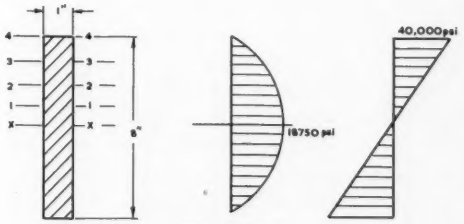


Station	$f_N = \sigma/2 + X$	$\text{Tan } 2\theta_N = \frac{2\tau}{\sigma}$	$2\theta_N$	θ_N	Key diagram
44	40,000	0	0	0	
33	32,100	.547	28° 42′	14° 21′	
22	27,300	1.41	54° 40′	27° 20′	
11	23,300	3.52	74° 8′	37° 4′	
XX	18,700		90°	45°	



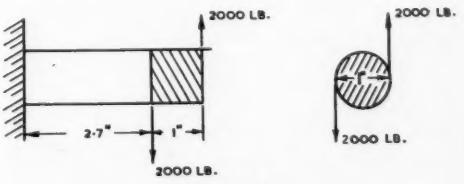


Picture 7

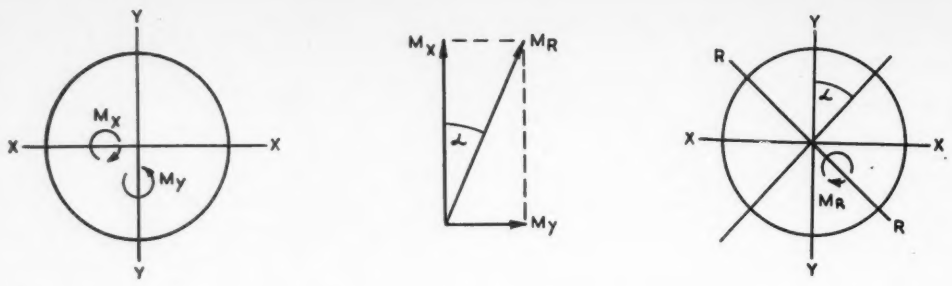


Picture 8

Picture 7. Case of tensile stress zero, principal stress numerically equal to shear stress. Picture 8. Combined bending and shear details. Picture 9. Bending and torsion are combined.



Picture 9



Pic. 10: circular tube under action of bending moments in two planes.

Designers' approach to combined stresses problems is shown

circular tube, under the action of bending moments M_x and M_y (PICTURE 10), the resultant B.M. is:

$$M_R = \sqrt{M_x^2 + M_y^2}$$

acting at $\alpha = \tan^{-1} \frac{M_y}{M_x}$

When $M_x = M_y$, $M_R = \sqrt{2}\, M_x$

and $\alpha = 45°$

Bending stress $\sigma = \frac{M_R}{Z}$ where Z is the section modulus (this has the same value about any axis for a tube).

Numerical Example No. 3

A circular tube AB, 1 in. OD (PICTURE 11) is supported at its ends A and B in loose bearings. A load of 400 lb. at right angles to AB, and at 8 in. radius from it, is applied to AB through a lever, the resulting torque being reacted at A.

Assuming that the max. direct stress (tension or compression) is not to exceed 44800 psi. and that the max. shear stress is not to exceed 29000 psi., calculate the minimum necessary tube thickness. (AFRAeS)

(a) Try 1″ *OD* x .058 in. thick tube

From tables, $A = .1716$ in.^{2}

$Z = .03822$ in.^{3}

Torque at $A = 400 \times 8 = 3200$ lb. in.

$$\tau = \frac{T}{2Z} = \frac{3200}{.07644} = 41{,}900 \text{ psi.}$$

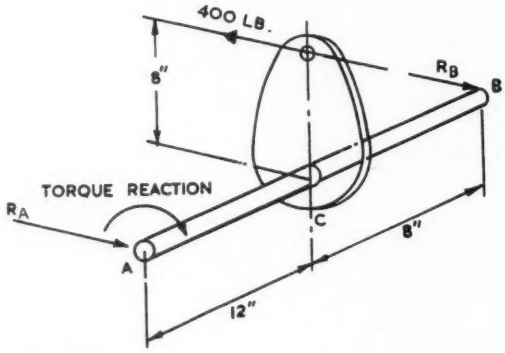
This is greater than the allowable of 29000 psi.

(b) Try 1″ *OD* x .120 in. thick tube

$A = .3318$ in^2.

$Z = .06542$ in^3.

$$\tau = \frac{T}{2Z} = \frac{3200}{.13084} = 24{,}450 \text{ psi.}$$



Reactions

$$R_A = \frac{400 \times 8}{20} = 160$$

Bending Moment M (under load) $= R_A \times 12 = 160 \times 12 = 1920$ lb. in.

$$\sigma = \frac{M}{Z} = \frac{1920}{.06542} = 29{,}350 \text{ psi.}$$

Max. principal direct stress

$$= \frac{\sigma}{2} + \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$$

$$= 14{,}675 + 10^3\sqrt{14.675^2 + 24.45^2}$$

$$= 14{,}675 + 10^3\sqrt{215 + 596}$$

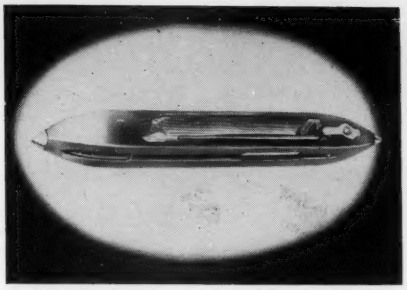
$$= 14{,}675 + 28{,}500$$

$$= 43175 \text{ psi.}$$

Max. shear stress = 28,500 psi. from above

This tube thickness is therefore satisfactory.

Note that the direct shear stress does not enter into this calculation, because the shear stress due to torsion and the bending stress both occur at the extreme fibre of the section, where the direct shear stress is zero.★



Vulcanized fibre textile shuttle facing takes repeated impact but does not splinter.

Vulcanized fibre can absorb impact

By JOHN MACADAM
NATIONAL VULCANIZED FIBRE CO.

Weighing half that of aluminum, it is a tough, resilient cellulose plastic

Designers reduce costs with this material that forms and machines easily

VULCANIZED FIBRE, one of the better plastics known to industry is a versatile, cost-saving, cellulose plastic material. It is one of the strongest industrial materials, yet it weighs only half as much as aluminum. Tough and resilient, it is capable of absorbing considerable impact without damage. And it is easy to form and machine. With excellent mechanical strength, it also has good electrical insulating properties.

Four basic grades of vulcanized fibre are recognized in NEMA specifications:

Electrical insulating grade, generally called "fish paper," is used for motor and generator insulation.

Commercial fibre is a mechanical and electrical grade for general-purpose applications.

Bone fibre is an exceptionally hard, dense grade, used where close machining tolerances are specified or where unusual wear or abrasion will be encountered.

Trunk and Case fibre is a tough, abrasion-resistant surfacing material for plywood.

In addition, many variations of these four basic grades have been developed to meet special requirements. These variations include an abrasive grade, a white tag grade, bobbin grade, railroad grade, hermetic grade and others designed for specific applications. Vulcanized fibre is available in the form of sheets, strips, rolls, coils, rods, tubes and special shapes.

The making of vulcanized fibre is a relatively simple process. Paper is made from cotton fibres obtained by digesting clean cotton rags. Various types of paper are made, depending on the grade of fibre desired. Large continuous machines that brought automation to the vulcanized fibre industry years ago contribute toward its comparative low cost. The material can be made in virtually any color from pure white to black. Gray, black and red are most commonly used.

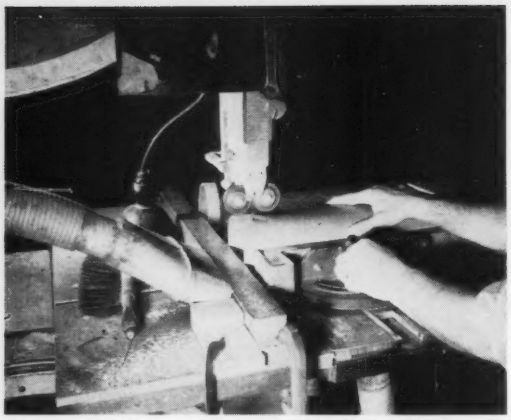
Maximum moisture content in vulcanized fibre, obtained from exposure to 100 per cent humidity, is 30 per cent. Absorption drops off sharply at somewhat lower humidities.

This tendency to "breathe" with the humidity affects the major properties of vulcanized fibre to varying degrees. If vulcanized fibre is used in close-tolerance applications where atmospheric conditions vary widely, allowance must be made for dimensional changes.

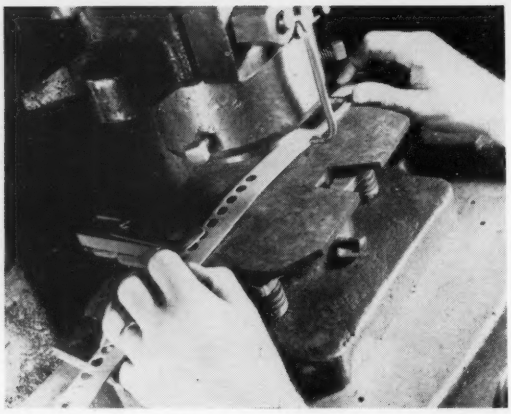
Flexural strength, Rockwell hardness and dielectric strength are also affected by moisture absorption. In certain applications, such as railroad track insulation, moisture absorption is an important advantage because of the accompanying improvement in impact strength. **Continued over page**

Mechanical Specifications

Vulcanized fibre has a tensile strength range of from 6,000 to 12,000 psi, depending upon the grade. Flexural strength limits are between 12,000 to 20,000 psi. Compressive strength is 20,000 to 30,000 psi. Shear strength is 11,000 to 15,000 psi. In addition, impact strength is 4 to 8 ft lb per in., Rockwell hardness is R60-R100 and the modulus of elasticity is 750,000 psi. Density is 0.036 to 0.0 54 lb per cu in. Dielectric strength is 150 to 250 volts per mil for a short time with ⅛ in. thickness. Water absorption is 15 to 25 per cent in a two hour period for ⅛ in. thickness. Thermal conductivity is 3 Btu/hr/ft²/deg F/in. Specific heat is 0.37 Btu/lb/deg F in vulcanizing fibres.



Vulcanized fibre shapes can be cut with band saw speeds ranging from 4,000 to 5,000 rpm by machine operator.



Fibre strips and sheet stock can be punched rapidly. There is no danger of chipping or cracking in process.

Sawing, punching, without cracks or chips prompts use of versatile fibre

Vulcanized fibre *(Continued)*

Vulcanized fibre is impervious to most non-aqueous liquids, including gasoline, oil and other petroleum products, as well as most organic solvents.

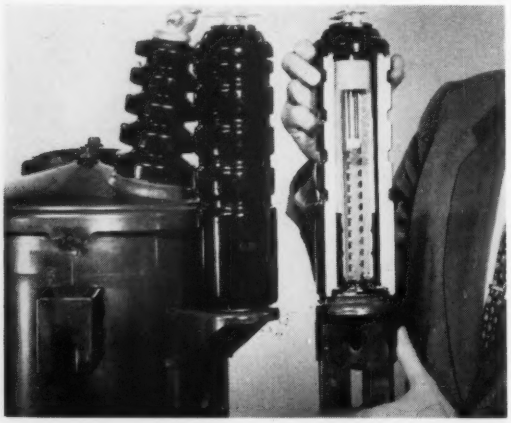
Vulcanized fibre has a power factor of 0.03 to 0.08 and a dielectric constant of four to seven in terms of 1,000 kc. It is one of the most arc-resistant of the available plastic insulating materials. Because it emits a neutral or uncharged gas under the heat of the arc, it is much more effective than refractory materials such as glass or porcelain.

Vulcanized fibre will not readily carbonize. Its cellulosic structure contains sufficient oxygen to combine in gaseous form with any carbon that might otherwise be deposited as a conducting solid. Some expulsion-type lightning arresters employing fibre tubes can withstand surge currents of more than 100,000 amp without showing a trace of a carbon track.

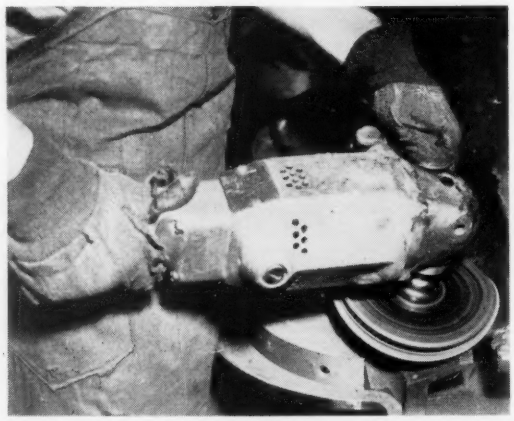
Under the heat of the arc, large quantities of neutral gases are produced consisting of approximately 50 per cent carbon monoxide, 45 per cent hydrogen, and a mixture of hydrocarbon gases and water vapor. Many arc-arresting devices are designed specifically to take advantage of this characteristic.

The gas evolution inside a tube creates instantaneous pressures. The insulating material must resist the tendency of the suddenly-applied stresses to rupture the tube wall and strip the threads that hold the metal end plugs. Here the impact strength or shock resistance of vulcanized fibre which is three to seven times greater than that of other organic insulating materials is of particular advantage. In addition, vulcanized fibre does not soften nor lose any of its mechanical strength when exposed to the high temperature of an electric arc.

Relatively thin sections of vulcanized fibre can be readily curved, bent and deep-drawn without sacrificing strength in any area. Usually the first step in form-



Arc-quenching in vulcanized fibre is shown in lightning arrestor which dissipates electric arc in arc chute.



Gear trains run with less noise and are smoother when fibre gears are used in combination with metal gears.

ing vulcanized fibre sheet or tubing is softening it by immersion in hot water (160 to 210 deg. F.) or in a live steam chamber. The immersion time required depends on the thickness of the material and shape of the part to be formed. Simple shapes can be formed after merely wiping the material with a wet cloth or dipping it in water. It may be necessary to soak the fibre 30 min. or longer for thicker or more complex shapes.

When sufficiently plasticized, the fibre is placed in a heated metal forming die and held there for a period ranging from a few seconds to several minutes to "set" the new shape. Die temperature, determined by both the thickness of the material and the shape of the part, is usually in the range of 220 to 300 deg. F. The plasticity of wet vulcanized fibre is such that the material can be stretched as much as 25 per cent and compressed by about 50 per cent. A three in. circular disk can be drawn to 1½ in. diameter and about 1⅛ in. deep. For a part roughly cubical in shape, depth of draw should be about one-third the length of the diagonal of one face. Depth of a spherical draw, as in the crown of a protective helmet, can be approximately one-half the average diameter of the opening. For parts such as helmets that have sharp curvatures, the material should be 1/16 to 3/32 in. thick to permit a good draw and, at the same time, provide the necessary strength and rigidity in the finished part.

The fibre can take punishment

Although dry vulcanized fibre is essentially a thermoset material below 250 deg. F., it becomes moderately thermoplastic if heated to about 350 deg. F. At this temperature it can be post-formed into relatively simple shapes, but extent of draw or bend obtainable with heat alone is considerably less than that possible when the fibre is wetter.

Vulcanized fibre can be sawed, drilled, milled, turned, punched, sheared, and otherwise machined as easily as brass or wood. It can be cut with a circular saw to provide smooth edges and close tolerances, or with a band saw when the finish of the cut surface is not critical. Circular saw cuts should be made at 2,700 to 3,200 rpm. Band saw speeds should be between 4,000 and 5,000 linear ft. per min.

Vulcanized fibre can be milled with high-speed tungsten carbide or Carboloy-tipped tools. Machine speed should be about the same as for brass, approximately 400 ft. per min. The material may also be cut with power-operated metal squaring shears. A straight knife will give good clean edges on material up to ⅛ in. thick.

For drilling, a high-speed drill is recommended. The drill should not be forced, especially when working parallel to the laminations. It is advisable to back the drill out frequently for cooling and to clean away chips.

Vulcanized fibre can be tapped with standard metal taps. However, the ream should be 0.003 to 0.006 in. larger than the final diameter desired because of the spring-back tendency of the fibre. The material can be punched easily. Compound dies are recommended for intricate pieces and progressive dies for high-speed fabrication. Punches must be made over-size for hot punching since the fibre shrinks during cooling. The amount of oversize needed depends on material thickness, temperature and size of the punch. For a ⅛ in. hole in 1/16 in. stock, the punch should be 0.003 to 0.005 in. oversize. For a ⅛ in. hole in ⅛-in. stock, the punch should be 0.012 to 0.015 in. oversize. Cold punching produces good edges on ¼ in. stock but

Above, the vulcanized fibre is easily formed to complex shapes in the heated metal forming dies at the left.

thicker stock should be heated to about 180 F. Shaving will produce smooth edges if the edge of the die is beveled at about 45 degrees for a distance of 1½ to 2 times the thickness of the stock. Fibre up to 1½ in. thick can be shaved cold, but thicker sections should be heated before shaving.

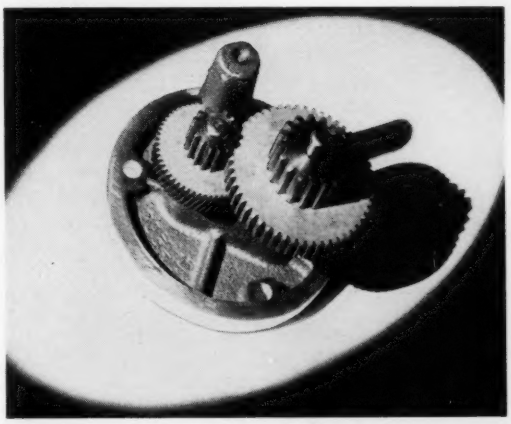
The material lends itself to finishing with enamels or lacquers. It can be sanded or buffed to a glass-smooth finish or embossed for decorative effects.

Many abrasive disks for grinding and polishing in the metalworking industry have a thin backing of vulcanized fibre. Vulcanized fibre provides the needed combination of resilience and tear resistance which allows the disk to spring back into shape even after high speed grinding on curved surfaces and corners where contact pressure is concentrated in one section of the disk.

These abrasive disks are usually made by coating the fibre with a 0.030-in. thickness of resin binder and depositing the abrasive grains on the resin. Heavy duty abrasive disks are constructed with an intermediate layer of cloth between the fibre and the abrasive.

The electrical equipment industry makes use of the insulating and arc resisting qualities of vulcanized fibre in a wide variety of products.

One typical application is the use of vulcanized barriers in the circuit *(Continued on page 76)*



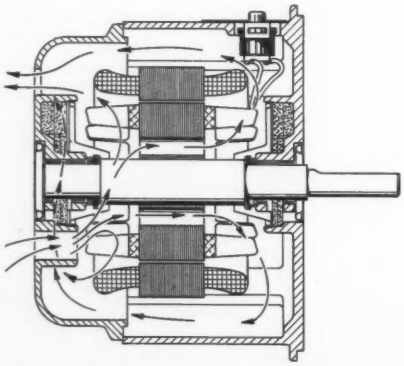
Fibre provides backing in abrasive discs, gives it resiliency and resists tear for grinding and polishing.

The orthodox oil burner motor gets a face lifting with all-new design

A. J. GIRDWOOD
CHIEF ENGINEER, LELAND ELECTRIC

After exhaustive studies and experiments, it took only 17 months to get a newly designed electric motor into regular production at a Canadian firm

Oil burner motor is designed with completely new approach, not just modifications.



Cross-sectional view of new oil burner motor showing the air flow through interior.

WHEN AN INDUSTRY meets heavy competition, fresh viewpoints on design must come fast. The electric motor industry has been in this position for quite a while. New NEMA frame standards, saving some materials were adopted but they only amount to foot and shaft height changes that fit better designs made long ago.

Modification alone was not enough; a new approach was necessary.

The idea came to take a special application motor popular in industry on which sufficient volume of business was available and to design it as if it were the only motor to be made in the factory. So that way, every part would be designed for the best economical service. To offset the obvious advantages of the plan, certain cost problems had to be considered.

Breaking the length of run of standard parts;

Amortization of the special patterns, tools and fixtures were among them;

Lengthy and costly experimental and test work had to be done on one motor to satisfy the company that it came close to being the best that could be made with modern design knowledge.

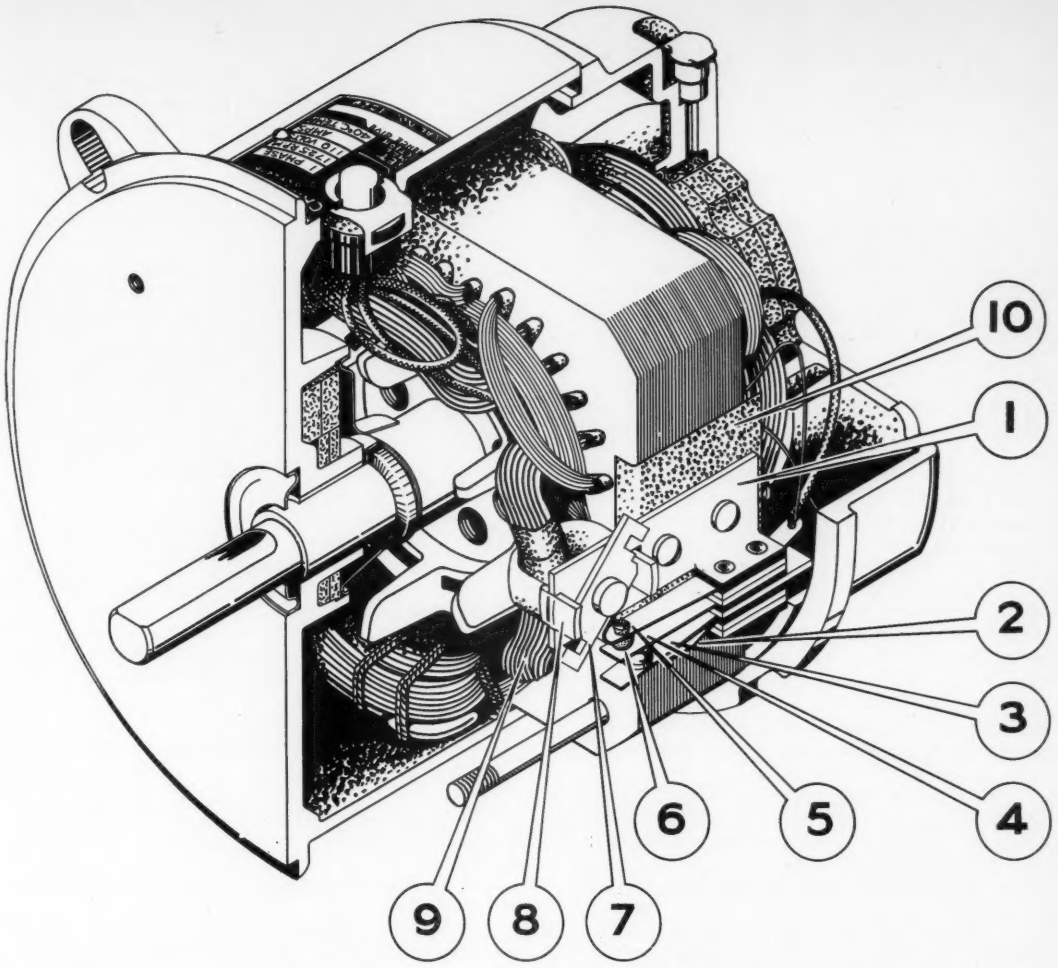
It did not take too long to decide that the study should be made on the oil burner motor, and it certainly had volume sales—157,000 in one year.

The chance of success in redesigning the oil burner were excellent because small motor design had been patterned after the washing machine motor. The burner motor had to meet entirely different requirements.

Economy of materials was put high on the list. If economical design posed manufacturing problems, the cost of overcoming them was to be included as capital cost.

In every possible way, while maintaining material economy, the motor was to be economical to manufacture. The number of parts were reduced to a minimum and the assembly was designed uncomplicated and foolproof in an effort to do this.

The motor was to be rugged in appearance and service. At the same time it was to be neat and attractive. Its new appearance, however, was supposed to look a little bit like the company's familiar product.



Relay components in new oil burner motor: 1. Brass mounting plate; 2. Solid backstop for contact assembly; 3. Stationary contact spring moves up to breakstop providing wipe; 4. Moving contact and spring; 5. Actuating spring which moves contact through insulating buttons; 6. Sliding insulation button eliminates friction chatter; 7. Armature; 8. Pole shoe; 9. Winding; 10. Fish paper for electrical clearance and adequate creepage.

Although in theory the basic arrangement was standardized by Nema on two rabbet diameters and two bolt hole centres with one shaft and one lead arrangement, actually dozens of different lead arrangements were in use and must be met if sales volume was to be achieved. In addition both right and left hand mounting lug arrangements are in use as well as differing drive and oiler arrangements, to provide clearance from various parts of the different burners.

The requirements of the Approval's authorities had to be met, in this case the CSA.

The designer had to see a complete design in his mind's eye and convert it to information for the draftsman.

A designer must have three dimensional imagination, but more than this, he must see the fourth dimension of mechanical functioning. He must also visualize a fifth dimension of power flow; in as electrical energy, and out as shaft energy and as losses. He must consider those pulsating forces which are energy yet are not energy because they come and go. But they do add noise. Even deterioration or wear cannot be considered entirely separately. For these reasons then design is an art controlled by science.

Much has been discussed about mathematical and scientific design versus intuitive design. Actually no conflict should exist. Both methods must be exploited to the full.

The most important use of mathematics lies in the preliminary studies.

In the intuitive stage the machine is visualized and reduced to sketch and description.

Mathematics is again resorted to "proveup" on paper the conceived design.

Where a high investment and high production are involved both mathematical and intuitive possibilities will probably be explored by prototypes.

The basic special mechanical feature of an oil burner motor is the face and lug mount This provides an oppor-

(Continued over page)

Oil burner motor *(Continued)*

tunity to remove the heat generated by the losses of the motor by conduction to the face and across into the fan housing. Even the best mechanical joint conducts heat poorly. A two-piece construction with the active electrical and mechanical parts assembled inside the integral shell and drive end bearing bracket is better than the more conventional light steel shell or wrapper with a joint of small area between the shell and the drive end flange. With ordinary grey iron the approach is rather impractical because the length of shell required combined with practical draft requirements made the frame too heavy and too costly.

Shell cast iron gave a light weight casting of good appearance. Because of the close tolerances to which shell castings can be made, machining is economical.

One problem in using shell castings is the high cost of the molds. In the initial design particular care was taken to meet the many demands of various users.

There are two basic standard mountings having slightly different bolt hole circles and rabbet dimensions. Fortunately the larger is more commonly used. Largely because of the accuracy and the light sections possible with shell casting it was found quite possible to provide slots in the lugs to take the holding on bolts which bridged the two requirements while keeping the outside of the lug not too large for the small diameter bolt circle. The small diameter rabbet is of course produced by additional machining.

Although the standard provides that the upper lug be on the right side when looking at the end opposite the shaft a number of burners require a left hand lug. The provision of an additional oiler boss made it possible to manufacture for this assembly.

By using a shell diameter a little larger than absolutely necessary considering the electro-magnetic design a large part of the shell surface was kept available for this purpose. At the same time excellent clearance from the winding was provided for ease of assembly.

The basic feature of the design of the front end frame is the ventilating arrangement. Closed motors have been usually used in the past largely because the standard arrangement of switch end frame did not meet the requirements of the Canadian Standards Association and the Underwriters' Laboratories. They required that the arrangements be such that if a winding melts the molten metal cannot fall from the motor. Since the normal ventilating arrangement of the switch end was often of little value, the usual means of meeting this requirement was by means of a closed motor.

Having decided to consider an open protected motor the requirements of a good ventilation were considered which meant that the air intake must be as close to the centre of the motor as possible and must be baffled to a point fairly close to the top of the fan to prevent recirculation and loss of ventilating air. The exhaust air openings should be toward the outside of the motor and should be as remote as possible from the intake and should if possible be above it so the warm air leaving the motor will not re-enter.

The motor had to be drip-proof. The opening should not pass a ½-in. rod and the castings should be producible without coring. A relatively large oil storage reservoir was desired.

Offsetting the oil storage to the motor and making the outside face flat provided a ready answer to these problems. Air was drawn in through a semi-circular slot near the bearing and under it and discharged through a similar but longer slot near the top.

A rather extreme form of squared off or scrapless die arrangement was decided upon to permit the greatest use of the steel.

Considering the economics of lamination design; if the motor diameter is considered the measure of output, then the ratio of outside measurement to rotor diameter all squared would represent the iron cost factor, all other things being equal. The company's present basic design was a slightly squared circle. A competent competitive round design was taken as the basis for round design.

The Old Leland Design had an iron cost factor of 1.0; the Round Competitive design was 1.1; and the Scrapless Square was .80.

The economics of the round design can be improved by the use of gang dies. If a 15-gang die is used, the cost of material can be reduced to1.01.

Thus by this means alone the lamination steel purchases were reduced by 20 per cent.

Actually due to accumulated economics the lamination steel required to be purchased to produce this motor is exactly 40 per cent of that for the old design.

In design particular care was taken to meet many, varied demands of users

The rotor uses die cast aluminum in the squirrel cage winding. In general the die cast rotors were designed to replace exactly the old welded brazed or soldered copper rotor which generally used round copper bars in round holes.

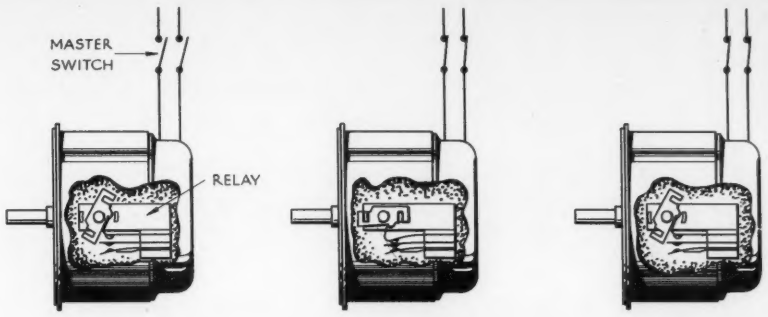
When it is up to speed it is better for the resistance of the rotor to be as low as possible. For starting purposes it should be quite high if high starting torque is required.

General purpose lamination design then uses a fairly high rotor resistance in order to obtain adequate starting torque for high torque applications. This results in a relatively inefficient design for full load full speed operation.

Since this lamination was being designed primarily as an oil burner motor it was given a starting torque only as high as was necessary with an adequate margin of safety. Information on the maximum torque requirements was obtained from the oil pump manufacturers and factors of safety and allowance for undervoltage starting added.

Most small single phase motors other than shaded pole motors use a centrifugal device combined with a switch to open the circuit to the start winding when the motor is up to speed. Such devices have performed reliably and have been the subject of a great deal of development work over many years. But these disadvantages, relatively costly particularly in the more reliable designs is one of these. They require space, making the motor more bulky and increasing the cost of frames and shafts. And they represent the cause of a fairly large proportion of all motor failures.

Relays of various kinds have been used, particularly on hermetic refrigeration motors, but in general their cost exceeded the centrifugal device.



	STOPPED	STARTING	RUNNING
Master Switch	Open	Closed	Closed
Stator Current	Nil	Locked Rotor Value (8 amp.)	Running Value (2.7)
Pole Piece 8	De-magnetized	Heavily magnetized	Weakly magnetized
Position of Rotor 7	Oblique	Horizontal	Oblique
Actuating Spring 5	Effective	Overcome	Effective
Contacts 3 and 4	Open	Closed	Open
Starting Winding	Disconnected	In circuit	Disconnected

RELAY OPERATING SEQUENCE

The engineering departments of the company had about 9 or 10 years ago designed a small relay for a very small motor, about 1/30 hp which had worked quite well. It had a balanced armature and thus was not gravely affected, position or acceleration sensitive. This relay was adapted to operation by the end winding of the motor and to fit largely into the space between the flat surface of the stator lamination and the shell.

Despite its deceiving simplicity when finally produced, hundreds of variants of this relay were tried before the design was released for production. Looking at the illustration it would consist of:

(1) A brass or non-magnetic mounting plate;
(2) A solid backstop for the contact assembly so that the closed position of the armature is controlled to control the drop out current.
(3) The stationary contact spring—the term is relative as it moves slightly up to the breakstop thus providing "wipe."
(4) The moving contact and spring.
(5) The actuating spring which moves the moving contact through the insulation button.
(6) Sliding action of the insulation button introduces sufficient friction to eliminate chatter. The actuating spring is operated by the armature (7) through a bent back portion. This bent back portion makes it possible to produce a spring force position curve which can be matched by the torque position curve of the armature.

Wedging action takes place considerable increasing the available contact pressure while maintaining a reasonable opening. In the "at rest" position with only running current in the windings this portion provides enough friction to prevent the buzzing often encountered with current operated relays.

The armature (7) pivots relatively loosely on a non-magnetic (in this case brass) pivot pin. Its shape was arrived at by cut and try to match the spring characteristics. It is operated by attraction of the pole shoe 8 magnetized by the passage of current in the winding 9. The whole is mounted on the stator by two screws. Electrical clearance and creepage is made adequate by a fish paper separating 11.

The current in the main winding at locked rotor is 8 amperes and when up to speed 2.7 maximum. Since force varies with the square of the current, the ratio of force at locked rotor to that at normal operating speed is 9 to 1.

The relay will not wear out

The relay as at present designed is not a general purpose device. Only by careful matching to the start winding and the general motor characteristics can it be made successful. At present there appears little hope that it can be applied to general purpose high torque motors.

However, extensive life and general operating tests have verified its suitability for this oil burner motor. In addition to saving space and cost it eliminates switch failures due to improper washering or washer wear. Its lack of heavy moving parts or high impact makes it impossible to wear it out mechanically while the contacts have a life expectancy of over 50 years in normal operation.

An auxiliary advantage is that the master relay of the oil burner only has to close the main winding. Since all relays have some bounce most contact damage is done on closing. The main winding current is 8 amperes where as the total current is 16. It is known that some motors draw 25 to 30 amperes. On one test the difference

Continued on page 68

Jonometers Measure Radiation Instantly

German firm produces a pocket-size gammagauge that generates 500 v. high tension by a couple of shakes then reacts to X-rays, gamma rays

Gammagauge which generates own high tension is shown with interior components exposed, left, and covered.

By ROBERT GERWIN
GERMAN CORRESPONDENT

A POCKET-SIZE gammagauge, that requires no battery or power supply and indicates the intensity of radiation immediately has been developed by the West German firm of Messrs. Erath and Futterknecht.

Known as the "Jonometer," it is being marketed by Nassau Distributing of New York. Price of the device is about 24 Canadian dollars. When mass production begins its cost is expected to drop to eight dollars.

No larger than a small flashlight and as handy as a fountain pen it weighs only 1 lb. 7 oz. It is just 4⅜ inches long and ¾ inches in diameter.

Detection and measurement of gamma rays and X-rays have presented an increasingly important problem with the advent of atomic power. And radiation from these sources, unlike sweet or bitter odors, or heat and cold, cannot be sensed. Therefore, since these rays are dangerous, when exposed to them in quantity, it has been necessary to gain a close measurement of their presence. Actually, a man can take a limit of 0.3 r per week or 0.05 r daily without danger to himself or future children. The radiation is measured in r which represents the international Roentgen unit. If the limits are exceeded sterility and death may result.

Intensity of radiation can be measured by the well-known Geiger-counter, but its use is awkward and cumbersome for daily checks.

Sensitized films, already in use, have been adapted for day-to-day checks but they do not provide the answers until they have been developed, which may be dangerously late.

The ionization chamber, closest cousin to the new gammagauge, tells the amount of radiation exposure right away. However, it requires an outside power source to produce the high tension for the electrodes. All gammagauges based on this principle have this serious handicap. Apart from this factor, it is very difficult to connect the electrodes of the ionization chamber to the source of high tension, since the insulation between the electrodes must be extremely good. A simple socket cannot be used outside the chamber. And because of the changing humidity of the normal air an uncontrolled current will flow in the socket falsifying the result. Some gauges have used an induction coil which is inside an airproof case enclosing the electrometer and the chamber. But it is also necessary to produce an electro-magnetic field for the coil and at the same time prevent the chamber from being discharged via the coil. This is not easy.

The ionization chamber in the earlier gammagauges consisted of two electrodes well insulated from each other with a small air-filled space between. The plates are connected to the electrometer which measures the tension between them.

The electrodes are switched momentarily to a high tension source which charges the ionization chamber. When the radioactive rays strike the space between the loaded plates ions are produced. This makes a feeble current flow between the electrodes, which in turn causes a drop in the potential as the condenser is discharged. A pointer on the electrometer then goes down accordingly. In this instance, the loss of the charge is proportional to the quantity of radiation, which is shown on an electrometer built into the new instrument.

Generating its high tension by itself, the new Jonometer is simply shaken a couple of times, its knob turned and it is ready.

The body is hermetically sealed so it is waterproof. It can be washed and sterilized after daily use the same as a clinical thermometer.

Arranged in the upper section of the Jonometer (see diagram) is the ionization chamber. One of the two electrodes is the body whose inner walls are covered with a thin metallic film. The other electrode consists of a small brass pipe in the middle of the chamber. At the top of the pipe is an electrometer specially designed for the Jonometer. One of its electrodes, similar in shape to a fork, is connected to the pipe. The other electrode is a small metal sheet which is positioned like the balance wheel of a watch.

When it is charged the metal sheet is pulled between the two ends of the fork. At other times it is kept out by a small spring.

High precision of the gauge demands jewel bearings for the moving electrode. Divided into eight equal parts of 0.025 r, the scale reads from 0 to 0.2 r. The gauge is accurate to within ten per cent. Even when there is no radiation, the Jonometer will register 0.01 r within ten hours as a result of ever-present cosmic rays.

Gammagauges have many uses

The generator in the new gammagauge will produce about 500 volts in the same way as the old-fashioned static machine. It does this by the simple rubbing of glass. A small plastic container moves up and down inside whose upper part is metallized with a small number of glass beads covering the bottom. When the Jonometer is put on its end the beads roll to the opposite side of the container and push against the metallized part.

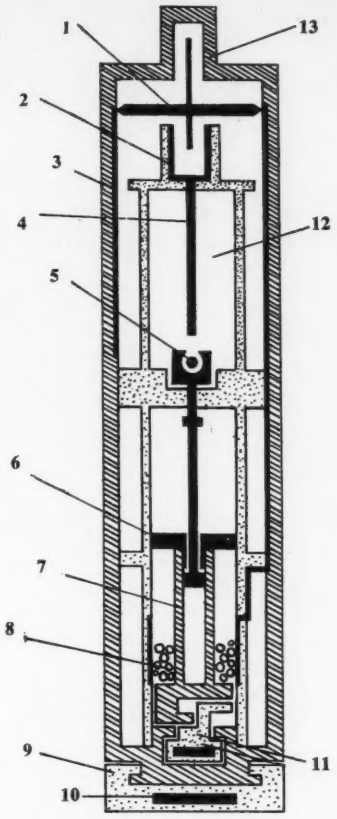
Negative electricity is thereby produced which can flow to the central part of the ionization chamber. When it is turned to its ordinary position, an automatic switch interrupts the connection between the central electrode and the beads. The gauge must be shaken at least twice to produce the required charge.

When the loading procedure is over the generator must be fixed. This is done by two corresponding knobs, one inside the airproof body, the other outside. There is no mechanical connection between the two knobs, but they both have a similar magnet. If the outside knob is turned the inside one turns as well. This action causes a bolt to be pushed into the bottom of the bead container. If the Jonometer is stood on its head, the glass beads will swirl around but they cannot charge the ionization chamber since there is no metallic connection.

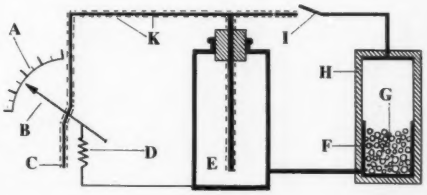
Hospitals, factories and laboratories have already put the gauge to use wherever X-rays and radioactive isotopes are present. It could also be very effective in event of an atomic explosion.

A healthy individual can take up to 12 r without serious injury. With the Jonometer it is immediately possible to tell if this point has been reached. For instance, if the pointer goes from 0 to 0.2 in one second, 12 r will be reached in one minute. However, if the pointer takes one minute to go the same measure an hour's exposure will be safe. If the pointer requires a half hour to cover the distance then it will be safe to stay in the surroundings for 24 hours.

Developed for detecting and measuring X-rays of normal wave length and the gamma rays, the Jonometer can be easily adapted for measuring the radiation from Cobalt-60. ★



Cutaway, actual size, with 1. Moveable electrode carried in jewel-bearings; 2. Fixed, fork-like electrode of the electrometer; 3. Body of ionization chamber; 4. Central electrode; 5. Automatic switch; 6. Metallized cover of bead container; 7. Plastic bead container; 8. Glass beads; 9. Outside knob; 10. Magnet; 11. Inside knob with magnet and bolt as lock; 12. Ionization chamber; 13. Scale.



Basic wiring diagram shows A. Scale; B. Moveable electrode with pointer; C. Fixed electrode; D. Pull-back spring; E. Ionization chamber; F. Electrostatic generator; G. Glass beads; H. Body made of plastics; I. Automatic switch; K. Wires and other parts charged with negative electricity.

What makes stainless steel stainless?

By R. N. KINGSTON

The strange reasons and recipes that led to its development are told here

STAINLESS STEEL is in many things; from golf clubs to store fronts; tableware to autos and cutlery; chemical processing vessels to high pressure steam turbines. It is in so many things and we have become so familiar with it, that we tend to ignore it. However, if we were to lose it, we should be back in the dark ages, at least in a metal sense.

The origin of stainless steel is a fascinating story since each of its now well-known characteristics had to be discovered separately and finding out about them produced, at the time, some apparently highly contradictory results.

About 1820, Michael Faraday is reported to have been looking over some steel specimens in his laboratory and was surprised to find one which was bright and shiny, while the others were covered with rust. On checking over his experimental data, he found that the uncorroded specimen was from a small melt he had made containing chromium.

Although this part of the story may not be completely authentic it is known that in the first quarter of the nineteenth century, Faraday and Stodart in England, and Berthier in France, did produce steels containing chromium. Berthier was so impressed by the greater hardness of the steel and its improved corrosion resistance, that he recommended chromium steel

Stainless steels are divided into 3 main classes:

CLASS I: MARTENSITIC

The series of straight chromium alloys hardenable by heat treatment. In general, corrosion resistance is slightly lower than for the Class III grades but suitable for applications calling for a hardened stainless grade. The advantage of this series, of which Type 420 is typical, is the wide range of strength and wear-resistance properties available.

CLASS II: FERRITIC ALLOYS

This group of stainless steels consists of a series of non-hardenable, straight chromium alloys with a good corrosion and heat resistance. In some cases, these alloys can be used as substitutes for the more expensive Class III grades. In general, this group is noted for oxidation resistance at high temperatures, but is most commonly used as auto trim. Type 430 is by far the most popular item.

CLASS III: AUSTENITIC

Probably the best known group, is this 18-8 Series, or austenitic type of stainless steel, having initially 18 per cent chromium and 8 per cent nickel. The other grades in this group are built up from the basic analysis. The hallmark of this group is ductility. Throughout the plastic deformation range, these superlative 300 Series alloys, as they are called, have excellent forming characteristics. Other properties which distinguish this group are weldability, corrosion resistance, high temperature service, and low temperature stability. These alloys are not hardenable by heat treatment, but by cold working only.

A cartridge containing radioactive isotopes is lowered by nurse into one of the stainless steel tubes of the "hot atom bank" that is built into room floor.

for cutlery. Nearly a century passed before the discoveries of Faraday, Berthier and others resulted in any real progress toward the production of true stainless qualities in rustless steel; the necessity of matching the chromium content of chromium steels against the environment in which they were to be used was not fully understood.

Between 1904 and 1906 Guillet, in France, published the results of his work on a series of iron-chromium alloys, which were almost the counterpart of the "400" stainless steels of today and of iron-chromium-nickel alloys, which laid the foundation of austenitic, type 300 stainless steels.

In Germany, Monnartz regarded as the discoverer of stainlessness in stainless steels, as a result of his outstanding work published in 1911, identified "passivity" and the dependence of passivity on oxydizing, rather than on reducing conditions. He indicated further that molybdenum was capable of extending the corrosion resistance of stainless steel.

The researchers go further

Harry Brearley, chief of the research laboratory run jointly by Thomas Firth & Son and John Brown & Co. in Sheffield, England, took out a patent in 1916, which covered a steel containing essentially 13 per cent chromium with not more than 4 per cent carbon. This is practically today's type 420 stainless steel principally used for cutlery. Brearley's success was the result of his noting that the rustless qualities of chromium steels are considerably affected by their heat-treatment. He established, therefore, the useful range of chemical composition and of heat-treatment, which produced the Class 1, Martensitic, hardenable stainless steels of the present time.

At the same time Brearley conducted his experiments on chromium steels containing only sufficient carbon to enable them to respond to hardening by heat-treatment, Christian Dantsizen of the General Electric Research Laboratory was developing an alloy having approximately the same chromium content but with so little carbon that it was not hardenable, and possessed if anything, a slightly better corrosion resistance. His alloy contained 4-16 per cent chromium with 0.07-0.15 per cent carbon and gave rise to the present day Class II stainless steels which, further distinguished by their micro-structure, are known as the Ferritic alloys. The best example of this series is type 430 stainless steel, so widely used for chemical processing equipment.

The third man of this triumvirate is Edward Maurer of Krupp—the famous German steelmakers. A year or two before Brearley and Dantsizen completed their researches, Maurer developed the now famous "18-8" stainless steels. These comprise the Class III steels of today, which type numbers in the AISI system are the 300 group: These steels are Austenitic and non-magnetic.

The particular property, which confers corrosion resistance at normal temperatures on steel is called "passivity," because, when in that condition, the steel behaves in an inert or passive manner. This is the principal feature of the stainless steels. The word passivity must not be taken too literally, nor must it be interpreted as a condition conferring non-corrodibility. The true inference is that the rate of attack under corroding conditions is slowed to such an extent that the loss of metal is negligible. Here again it must be emphasized that a stainless steel may be passive in one corroding medium and yet be heavily attacked in another.

The generally accepted theory of passivity can be described as the formation of a tenacious, impenetrable, oxide layer on the surface of the steel, making it resistant to corrosive attack. Conversely, the removal of the oxide layer, by chemical or mechanical means, makes the metal surface active and subject to corrosive attack. The historical evidence shows that Faraday and Berthier had the right idea, when they added chromium to steel, in that its effect was to start the formation of an oxide film. With low chromium contents, however, this was incomplete and merely created a certain rustless quality, when the steel was exposed to normal atmosphere. When the steel was in contact with dilute

Class I, Martensitic, hardenable, stainless steel.

AISI type No.	Carbon %	Chromium %	Others %
403	0.15 max.	11.5-13	
410	"	11.5-13.5	
416	"	12 - 14	P, S or Se
420	0.30-0.40	"	
431	0.20 max.	15 - 17	Ni 1.25-2.50
440A	0.60-0.75	16 - 18	Mo 0.75max
440B	0.75-0.95	"	"
440C	0.95-1.20	"	"

Class II, Ferritic, non-hardenable, stainless steel.

AISI Type No.	Carbon %	Chromium %	Others %
405	0.08 max.	11.5-13.5	A1 0.10-0.30
406	0.15 max.	12 -14	A1 3.5-4.5
430	0.12 max.	14 -18	
430-F	0.12 max.	14 -18	S, P or Se
446	0.35 max.	23 -27	

Class III, Austenitic, stainless steel.

AISI Type No.	Carbon %	Chromium %	Nickel %	Others %
301	0.08-0.20	16-18	6-8	
302	0.08-0.20	17-19	8-10	
303	0.15 max.	17-19	8-10	S, P or Se
304	0.08 max.	18-20	8-11	
305	0.12 max.	17-19	10-13	
308	0.08 max.	19-21	10-12	
309	0.20 max.	22-24	12-15	
310	0.25 max.	24-26	19-22	Si 1.50 max.
314	0.25 max.	23-26	19-22	Si 1.50-3.0
316	0.10 max.	16-18	10-14	Mo 2.0-3.0
317	0.10 max.	18-20	11-14	Mo 3.0-4.0
321	0.08 max.	17-19	8-11	Ti
347	0.08 max.	17-19	9-12	Cb

Type 403 is widely used for steam turbine and compressor blades and for other highly stressed parts.

Type 410 is preferred, in the heat-treated condition, for valve stems and pump linings. As annealed sheet, it is used for linings in equipment, where abrasion resistance, as well as corrosion resistance, is needed.

Type 416 has an addition of sulphur, phosphorus or selenium to make it a free-cutting steel for the high production of screws, nuts, bolts and valve stems. It is not quite so corrosion resistant as 403 or 410.

Type 420 is the cutlery grade originated by Brearley. The carbon content is higher than the usual 0.10% of Type 410 to provide higher hardenability. This, in turn, requires a higher chrome content to maintain the correct balance for good corrosion resistance. The steel is tough and abrasion resistant.

Type 431, with the help of about 2% nickel, is the most stainless of the hardenable stainless steels. This is the American 16-2, very similar to the British "Two-score," used for pump parts.

Types 440 A, B & C are the hardest of the stainless steels. With increasing carbon content there is a requirement for more chromium, if the stainless qualities are not to be impaired through depletion of chromium by carbide formation. With these three compositions, the choice lies between hardness and toughness. Type 440C is the hardest, Type 440A the toughest. This series is used for surgical instruments, anti-friction bearings, valve seats, gauges and precision measuring instruments.

Turning now to Class II steels, in Types 405 and 406 improved corrosion resistance and softness is obtained, not by adding more chromium, but by alloying with aluminum, a much more potent ferrite stabilizer than chromium. These two steels are, in effect, the 12% chromium, Type 410 steel, made ferritic by aluminum.

Type 405 has just enough aluminum to prevent hardening by the formation of austenite at elevated temperatures, a valuable attribute when the steel is used in welded tubes and pressure vessel linings in the petroleum industry, where post-welding stress relief, by heat treatment, would be almost impossible.

Type 406, with an even higher aluminum content, becomes, in consequence, a heat-resisting steel. Its special role is in heating elements for toasters, waffle irons, heaters and heat-treat furnaces.

Type 430 is a very popular alloy, with a wide range of usefulness. It resembles Type 410, but, with its higher chromium content and low carbon, has better corrosion resistance. This steel is widely used for automotive trim, moldings, chemical-processing vessels and especially those used in the manufacture of nitric acid by the ammonia-oxidation process.

Type 430-F is the free-cutting version of Type 430, machinability being improved.

Type 446, often known as "25-chrome," has the highest chromium content of any of the straight chromium steels, and hence the greatest corrosion and oxidation resistance. It is, however, notch-sensitive, susceptible to 475 deg brittleness and subject to high-temperature embrittlement through the formation of sigma phase. This steel is primarily used in furnace applications, burner nozzles and heat exchangers.

As regards Class III, Table 1 shows the compositions and AISI type numbers of the "300" series, which, although more expensive than the straight chromium steels, has a remarkable combination of corrosion resistance.

Type 301, with the lowest nickel content of these stainless steels, is just austenitic and responds markedly to work-hardening, resulting in the formation of some martensite and in raised tensile properties. In addition to several grades of cold-rolled sheet and strip, the steel is available in the annealed condition, when rather more severe forming is needed. Type 301 is widely used for automotive trim.

Type 302 is the popular 18-8 stainless steel. Being more stably austenitic, it work-hardens less than Type 301 and is more amenable to deep drawing. It is also available in several cold worked grades. These two steels are in much demand for railroad passenger coaches, truck trailers and aircraft parts, while Type 302 is more popular in food-processing equipment and household items. Being subject to sensitization, both steels have limited use at elevated temperatures or, after welding, in corrosive media.

Type 303 is a free-cutting version of Type 302, made so by the addition of sulphur, phosphorus or selenium, either singly or in combination. It is used in screw-machining applications and for cold upsetting. Its corrosion resistance is slightly inferior to that of Type 302 because of its sulphur content.

Type 304 is a halfway house toward a desensitized stainless steel. Its low carbon content makes it much more immune to sensitization by exposure to high temperature or as a result of welding. It is a popular stainless steel for small bore tubing.

Type 305 is virtually an 18-12 stainless steel, the high nickel and low carbon content making it a very stable austenitic steel. It has been developed especially for deep drawing and spinning.

Type 308, 20-10, Type 309, 25-12 and Type 310, 25-20 are the super-austenitic stainless steels, having the highest corrosion and oxidation resistance of all. These steels are expensive, a factor which limits their use and all three are subject to sensitization, though Type 310 is the least affected. Types 308 and 310 are popular for welding electrodes, as their powerful austenitizing tendency ensures ductile weld metal. Types 309 and 310 have good oxidation resistance up to 1900 F.

Type 314, with its pronounced silicon content, is essentially a heat-resisting steel for furnace parts and retorts.

Types 316 and 317, having a high molybdenum content, are acid-resisting for special use in reducing acid conditions, as encountered in chemical processing towers and transportation tanks; also in digesters, pumps and evaporators used in the pulp and paper industry. They are also highly resistant to sea water.

Type 321 is the 18-8 analysis stabilized with titanium to make it free from intergranular attack, in corrosive media, after welding or exposure at elevated temperature.

Type 347 stabilized with columbium, is similar to Type 321 in its immunity to sensitization, which persists to about 1500 F, the limiting scaling temperature. These two steels are considered to be interchangeable but Type 321 has rather better forming characteristics and Type 347 better elevated temperature properties. Both steels are used in welded chemical processing equipment and for high temperatures.

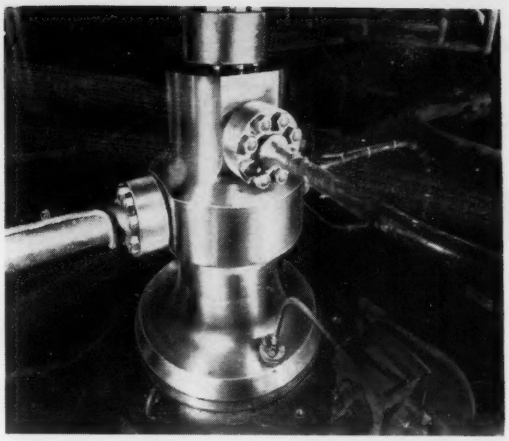
Stainless steel *(Continued)*

sulphuric acid—a strong reducing agent—the oxide film was destroyed and the steel attacked. Brearley was more successful because he added enough chromium to provide a complete oxide film covering. This was far more resistant to atmospheric conditions but still not capable of withstanding dilute sulphuric acid.

Attaining passivity through the building up of a protective oxide layer, is naturally dependent on an oxydizing environment. Nitric acid is a well-known passivator. Oxidizing salts such as chromates, permanganates and sulphates are also useful in this respect. On the other hand, hydrochloric, and the other acids of the halide group, are reducing. All corroding media can be ranged between fully oxidizing and fully reducing, with a large number in the intermediate zone. The ability of a steel to remain unattacked can be regulated by variation of its chemical composition and by its environmental temperature. Higher temperatures are usually more active and uncertain in their effects.

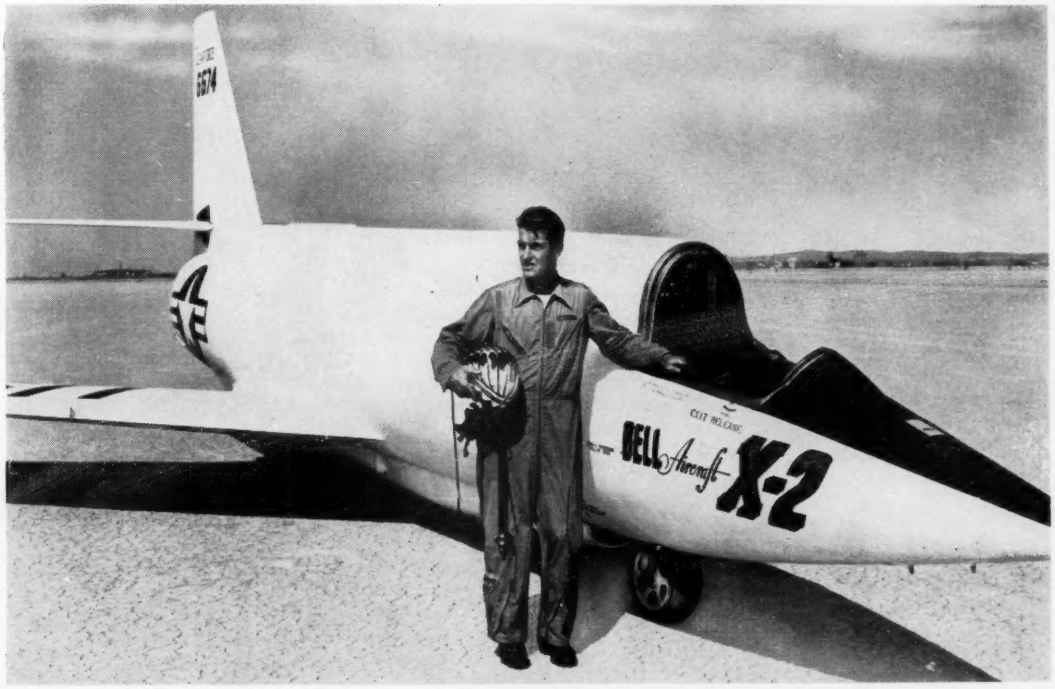
Chromium is the single element which, when alloyed with steel, has the strongest effect in achieving passivity. Elements of the same family as chromium, namely molybdenum and Tungsten, are also passivators, but not to the same extent. Useful passivity begins with 12 per cent chromium and increases as the chromium content is raised to about 30 per cent, at which figure the straight chromium-iron alloys possess their maximum corrosion resistance.

Steels containing chromium are notoriously susceptible to attack by chlorine, the negative ion of which causes localized corrosion or pitting. Any aqueous solution of hydrochloric acid is suspect and must be avoided and too much reliability, therefore, cannot be placed on stainless steels when exposed to salty atmospheres or to sea water. Special alloy additions, particularly molybdenum, special heat-treatment and an artificial increase in the oxidizing power of the corroding solution can reduce the effect of pitting but cannot be guaranteed to eliminate it.



Stainless steel forging above, six ft. high is reportedly largest, is part of chemical processing unit.

Next to chromium, nickel is the most important element in stainless steel and, in addition to improving mechanical properties, aids in resisting corrosion by neutral chloride solutions and by acids of low oxidizing power. This refers particularly to the 18-8 austenitic stainless steels which have the best combination of engineering qualities and of corrosion resistance, this latter being due to the broadening. *(Continued on page 65)*



Stainless steel wings and tail of Bell X-2 withstand heat generated at very high speeds by the air friction.

Change iron and steel into rich alloy by chromalloying

CHROMALLOYING IS A new heat treatment process at York Gears Ltd., Toronto, in which chromium diffuses into the surface of iron or steel and certain other metals, to transform it into a chromium-rich alloy. It is different from chrome-plating.

Since it is an alloying of the material itself, it is not a plating and cannot be peeled off. As a process it slightly resembles other diffusion processes such as carburizing, nitriding, sherardizing and calorizing. The surface of the metal after diffusion contains 5 per cent or more of chromium, its concentration decreasing with depth below the surface.

Chromalloying introduces a range of materials with new properties. It can produce a stainless steel surface on a mild steel core, giving a ductile material with resistance to corrosion and high temperature oxidation. On medium or high carbon steels a surface of hard chromium carbides is produced with a core which can be heat treated to the required condition without detriment to the chromium carbide surface.

In many ways the diffused surface has similar properties to ordinary austenitic steels, but a better comparison would be with a high-chromium ferretic stainless material such as 20 per cent chromium iron.

At temperatures up to 1,700 deg. F. chromalloyed steel and cast iron show excellent resistance to oxidation. In this field the process offers a wide range of savings to the manufacturer.

Practically every heat absorbing part for gas stoves so far has been tested in mild steel chromalloyed with excellent and money saving results. Nuts, bolts and screws for ovens of all types where heat oxidation makes disassembly and servicing impossible, can be chromalloyed to give long trouble-free life.

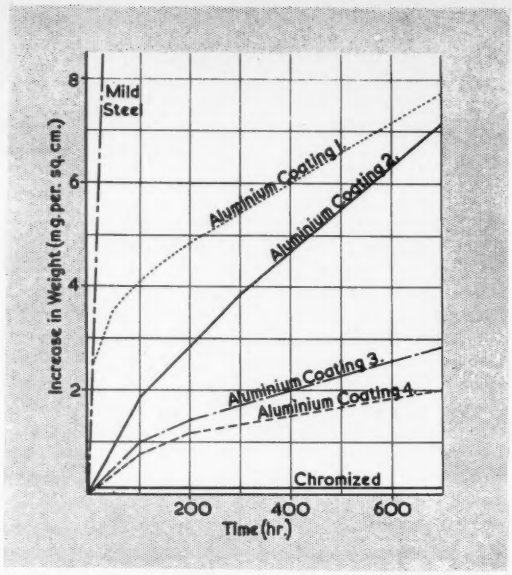
It is used as ducting made from mild steel sheets, cut and pierced prior to chromalloying, tubes for heat exchangers, agitators and fans for oil-fired muffles pyrometer tubes, quenching trays, heat treat fixtures.

All ordinary ways of welding can be applied to chromalloyed materials with care. Spot and resistance welding are not difficult. Arc or gas welding is best done with austenitic stainless steel welding rod, and the operator must be reasonably careful to avoid excessive overheating, to prevent oxidation of the steel core.

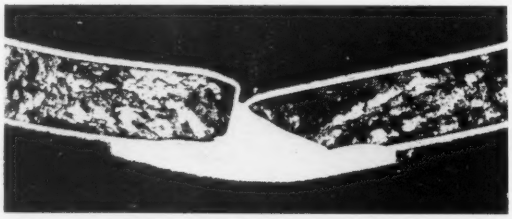
The steel core shows no tendency to "break through" to the surface. This is presumably due to the formation of a thin film of chromic oxide on the extreme surface of the chromalloyed layer, which prevents the breakdown of the coating at the moment of weld.

Tubes have been fabricated by shearing large chromized sheets to size, bending to form a tube, and welding the edges together. The exposed core at the edges is totally embedded in the weld deposit.

Chromalloyed material also lends itself to brazing by the usual techniques, with selected fluxes. Silver soldering can also be done, but a special flux has to be used as the chromalloyed surface does not tin easily.



Heat oxidation tests on mild steel at 700 deg. C. show increase after 1,000 hrs. as 0.15 mg. per sq. cm. on chrome steel with 147.7 mg. per sq. gm. uncoated.



Diffused material welded without steel core tending to break through is seen in this photo-micrograph.

The application of chromalloying to medium or high carbon steels develops a very hard and wear-resistant surface because of the high proportion of carbides in the chromalloyed layer. Subsequent heat treatment to improve the core strength is not detrimental to the surface hardness. Mild steels can also be given an abrasion resistance surface by carburizing prior to chromalloying.

Diffusion is an industrial process, and for most purposes the "as chromalloyed" finish is adequate. If a polished or satin finish is required most of the ordinary methods can be used. Chromalloyed low-carbon steels have very similar polishing properties to those of austenitic stainless steel. For mechanical polishing the same abrasives are used. Tumbling methods are satisfactory, as also the Rotofinish process. Care must be taken, however, that there is no undue abrasion at sharp corners.

Electropolishing technique is suitable, and special bath compositions have been developed which give a high lustre in a very short time. This method is likely to become widely used for chromalloyed parts. As with other methods of electropolishing the size and shape of the articles must determine its suitability.

Chromalloying gives designers a much wider range of materials. It also produces results which were never before possible in former processes. ★

Can the modern pilot jump and live?

By ALEXANDER BARRIE
MANAGING EDITOR

When George Smith leapt from his Super Sabre, he all but died. Now designers are trying again to make ejection safe

George Smith

HALF WAY through a routine test flight on February 26 last year, test pilot George Smith (31) lost control of his F-100 Super Sabre and fired the ejection seat trigger. In this dramatic moment he flung himself into both a 777 mph slipstream and aviation history. He had become the first man to bail out at supersonic speed and live.

As his body smashed into the pulverizing stream of low (6,500 ft.) altitude air, he suffered instant injuries serious enough to keep him a hospital case for six months.

For five days he lay unconscious, and when at last he came to, he could remember little of what had happened to him. Waiting research men were disappointed; for George Smith had experienced first hand the bone-breaking pressures that have for long played havoc with ejection seat design.

Much ingenious thought has gone into the mechanics of throwing a pilot clear of his aircraft in emergencies. But the time has come when high speed ejection may often be nothing more than the substitution of one kind of death for another. For with aircraft flying faster every year, most ejections will probably take place into air blasts that can kill.

Now the North American Aviation company has released news to **Design Engineering** of methods its engineers are using to overcome ejection hazards.

First they asked themselves, just what happens to the pilot during the critical second or two immediately after he leaves the aircraft?

An American magazine, Aviation Week, described George Smith's moment of agony like this:

"As the seat tumbled end over end and slowed down several hundred miles an hour in a split second, he suffered a deceleration force estimated at 40 times the pull of gravity. His weight increased to 8,000 lb. almost instantly. His eyeballs protruded from their sockets and strained against the eyelids. His internal organs were thrown about violently. Lips, ears and

The steel-and-rubber "George Smith" is manoeuvred into a rocket sled for a supersonic ejection test.

At 700 mph, the dummy acrobats to destruction. Can pilots fare better?

In the Mojave desert, engineers eject a dummy of test pilot George Smith at 700 mph. Cameras and instruments show that a pilot does not "tumble" as was formerly thought. Instead he pitches and yaws violently. Bottom picture shows how this experimental ejection ended — the pilot broke up.

eyelids fluttered fantastically in the supersonic wind which tore off his helmet and oxygen mask. The end of his nose was torn loose from his upper lip.

"The terrific blow on his abdomen and chest pumped blood violently to his head, where it was forced forward to his face by the tremendous deceleration, distorting his features beyond recognition. His stomach was blown up like a balloon by the air forced down his throat." And so on.

Note that the Aviation Week writer begins his description with the words "As the seat tumbled end over end . . ." Is he correct in saying this? Does the seat in fact tumble end over end, to spin like a wheel through space? North America's experiments suggest that probably it does not.

A group of "human factors" engineers recently started a series of elaborate tests in the Mojave desert which repeat in every way the famous ejection of George Smith. It is the first time that aviation engineers have duplicated a real life event of this kind.

A dummy was built and dressed

A detailed, $3,000 dummy was built and dressed to match Smith's size, weight and even his clothes. The joints were tightened and measured to duplicate the muscular resistance of a man of Smith's size and strength. Then, equipped with life-vest, helmet, and oxygen mask, the dummy was strapped in an ejection seat and positioned in the cockpit superstructure of the sled.

Inside the dummy's head and torso, engineers placed delicate instruments to record the huge acceleration and deceleration forces that Smith must have endured. Six accelerometers were used to measure vertical, horizontal and lateral forces at both head and stomach. Then the rocket sled was fired. At nearly 700 mph the steel-and-rubber George Smith was ejected.

From the time the dummy shot out of the sled until it hit the ground, data from the instruments was telemetered constantly to recording devices in a concrete building next to the centre of the track. Movements and forces were recorded each thousandth of a second on charts and graphs for later study by the engineers.

Besides this, a battery of 42 movie, still and sequence cameras along the track and inside the sled also recorded the story.

From all the data obtained, the engineers were able to confirm many of the theories they had already formed to evolve some new ones.

Among the new ones is the belief that, in dense air, a pilot ejected at supersonic speed goes through a series of violent rocking motions rather than complete revolutions of tumbling. It may be these violent changes of direction that cause the many hemorrhages due to "heavy-blood" as well as the bone-snapping flailing of arms and legs.

He also seems to suffer violent yawing motions; these rotate him sideways a full 180 deg. and quickly back again during his first two seconds after ejection.

These acrobatics greatly complicate the computing work now going on.

The engineers have put one of North America's giant electronic calculating machines on the job. This brain works out in half-an-hour arithmetic problems that would keep two men busy for 10 years without it.

Even so, it will be some time, probably many months until results of all this show themselves in improved ejection methods. And in the meantime, the North American company has little to say about what kind of improvements it thinks are coming.

There are three main hazards in high speed ejection: There is 1 the shattering airblast, 2 the yawing, tumbling and deceleration forces and 3 the fierce acceleration forces when the charge is fired.

While American engineers assess these hazards as the first step toward overcoming them, the British company Martin-Baker claims that its ejection seat now in use by the RAF is already safe.

In support of this claim is the story of a Hawker Hunter which went out of control at 700 mph over England recently. The pilot, Flying Officer Hedley Molland, followed George Smith's example and made the world's second supersonic ejection. But unlike Smith, he landed with only trifling injuries.

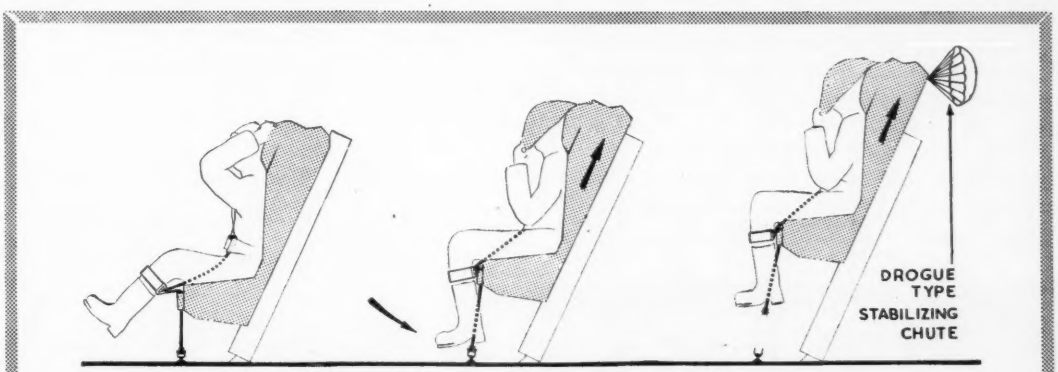
The Martin-Baker seat is fired when, using both hands, the pilot pulls down a handle over his head. This handle is part of the seat and he continues to hold it after ejection — so keeping his arms anchored against flailing.

In pulling down the ejection handle, he also pulls down a protective face mask which shields his face from the battering slipstream and prevents the terrific pressures from inflating him.

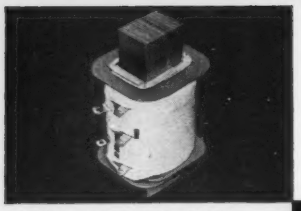
An ingenious system of cords automatically pins

Cont'd on page 69

Britain claims success with leg straps, face mask and stability drogue

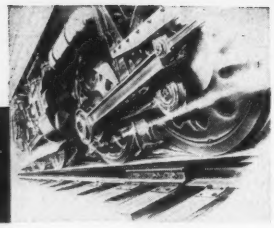


Left, he pulls the mask, centre, his legs are locked, right—he's away!

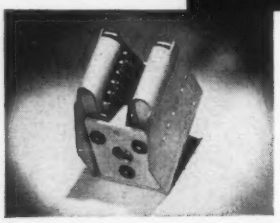


DIELECTRIC STRENGTH. National Vulcanized Fibre gives electrical parts high dielectric strength—plus toughness and excellent forming properties. Has ideal application as insulation.

NATIONAL VULCANIZED FIBRE



DURABLE—TOUGH—RUGGED. National Vulcanized Fibre rail joint insulation withstands years of continuous exposure and heavy pounding of today's high-speed railroading. Will not corrode or deteriorate.

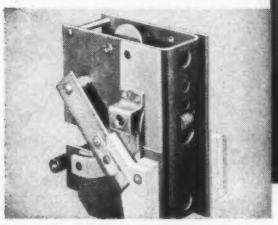


ARC RESISTANCE. In circuit breakers, National Vulcanized Fibre safely curbs electrical arcing without carbonizing or tracking. Easy to bend, punch and form. Light in weight. Heat-and-shock resistant.

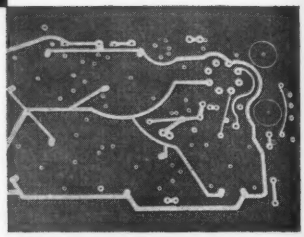
FOR MEN WITH IMAGINATION...

two materials of unlimited application

MACHINABILITY—MECHANICAL STRENGTH. New paper-base Phenolite not only has excellent arc resistance, but superior machining qualities as well. Great compressive and tensile strength.



CHEMICAL RESISTANCE. Chemical-resisting grades of Phenolite are unaffected by most corrosive fluids and atmospheres. Retain high strength, resiliency and dimensional stability

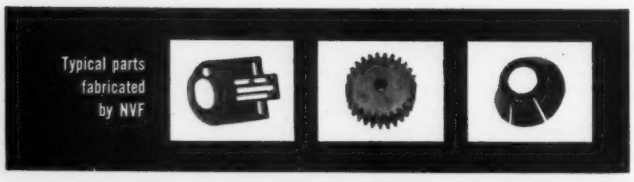


COMPACT DESIGN—ECONOMY—HIGH TEMPERATURE RESISTANCE. Printed circuits made of copper-clad Phenolite permit compact design, simplify production, reduce assembly time.

Here are six ideas to spur your imagination. They only *suggest* the many things that can be done with National Vulcanized Fibre or Phenolite Laminated Plastic.

The full list of current uses for these materials would more than fill this page and many more pages! Yet more are coming up almost every day. For NVF is not only the world's largest producer of vulcanized fibre. We also make a fulltime job of thinking up new improvements to our products—and new ways of using them to improve *yours*. Result: designers call our materials the most versatile ever.

Looking for an easy, economical way to improve production—or products? Team up with NVF. We're prepared to assist you all the way from initial design to the delivery of precision fabricated parts. Our new 16-page Catalog will give you full information about our products and services. Write for it on your business letterhead to Dept. N-2.



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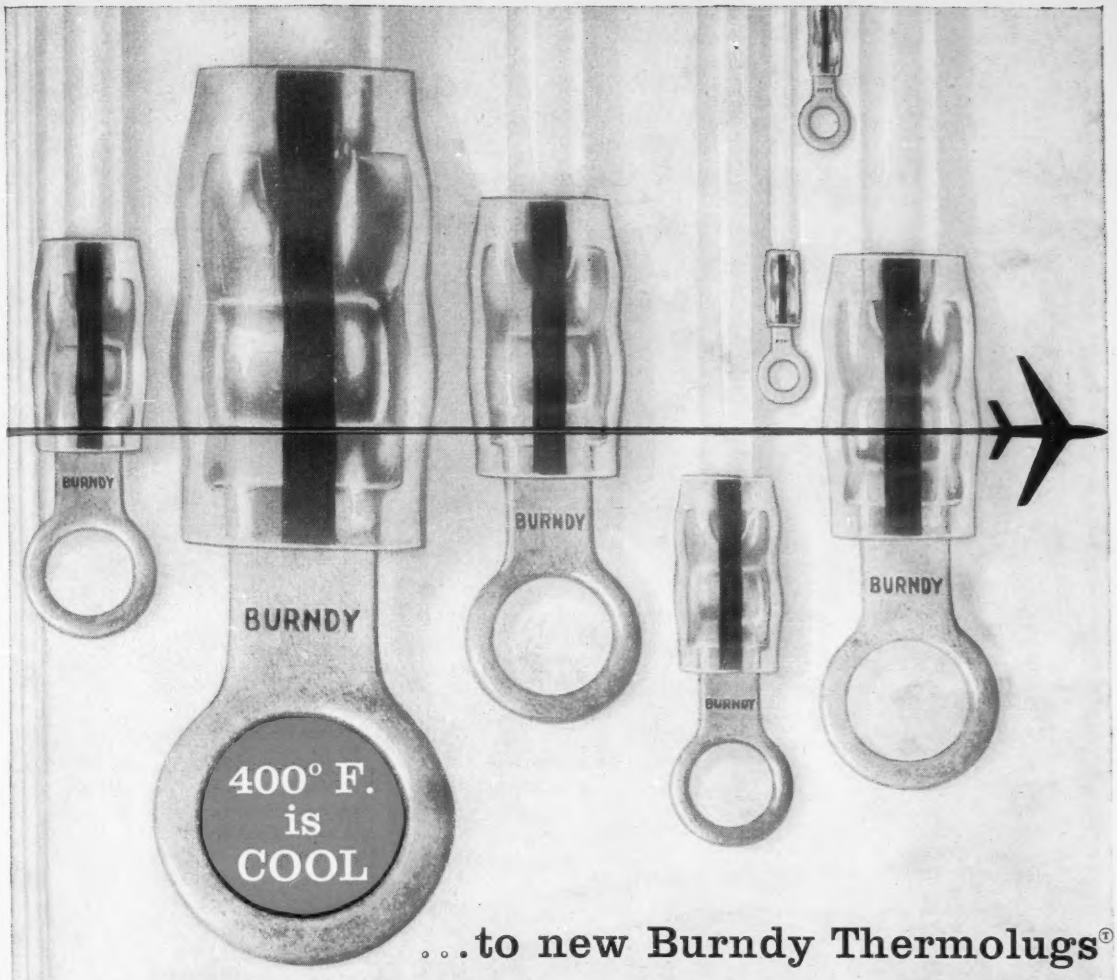

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When modern aircraft operation runs into electrical connection problems, depend on Burndy to find the answer.

Aerodynamic heating of modern high-speed aircraft produced temperatures throughout wings and fuselage which formerly were found only in engine compartments. New insulated compression terminals were needed to give sustained trouble-free service at these high ambient temperatures.

The answer was Burndy's new THERMOLUG—with high dielectric, crystal-clear insulation. After prolonged exposure at 400° F., the insulation remains tough and intact—maintains 1,500 volts dielectric strength.

THERMOLUGS are now available for high temperature insulated copper aircraft cable, sizes RM-22 through RM-8, meeting military specification MIL-W-7139A. For complete details, see your representative, or write direct to:

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Letters

Readers' viewpoints . . .

● Mr. Sid Bersudsky has a point when he claims U. S. designs are gaudy and impracticable (DESIGN ENGINEERING, November) but in his article he has neglected to answer a very important question . . . How does a Canadian go about designing, developing, tooling, manufacturing and, above all, financing an all-Canadian refrigerator or automobile?

It is all very well to say that American automobiles have vulgar chrome ornamentations and that refrigerators display the glitter of juke boxes but, let's face it, without U. S. backing in all phases of product development, especially in the appliance and automobile fields (which the author seems to have stressed) Canadian business simply cannot exist! As long as 15 million Canadians want the same type of merchandise as 150 million Americans, we are almost compelled to use the resources and designs of our neighbors.

At the present time, a few all-Canadian appliances are being merchandised against their (so-called) American counterparts. Compare them, Mr. Bersudsky, and see if your choice is anywhere close to that of our Canadian buying public.

Perhaps Canadians should be re-educated, or perhaps industrial designers should stop living in a world of theory and come down to earth.

W. E. KOOHTOW,
Toronto *Addison Industries Ltd.*

Contributor Bersudsky comments: The growth of Canadian manufacturing in the field of consumer goods has not kept pace with the tremendous growth of our primary activities—such as mining, construction, forestry and oil drilling. What our industry needs is less of the "me too" attitude expressed in Mr. Koohtow's letter, more risk capital and a realistic look at Canadian consumer needs. What about the fact that two of the largest U. S. appliance firms develop their traffic appliances in Canada for this market and sell large quantities competitively against surplus imports and adapted designs? Does Mr. Koohtow feel that this is "theoretical design" or is this hard-headed good business?—Ed.

● Having now received several issues of your new publication, I cannot help but feel that in your efforts to produce

a distinctively Canadian magazine, you are beginning to find some difficulty in obtaining suitable subject matter.

This is not surprising, in view of the rather limited scope of Canadian engineering accomplishment, but I feel your efforts to fill in with general interest articles on American and English developments is tending to make the magazine a somewhat more technical "Popular Mechanics."

Personally, I would like to see some reprints from foreign technical journals, of up-to-date, thoroughly technical articles, on an assortment of subjects which could be of interest *and use* to Canadian engineers.

Finally, I would like to compliment you on your excellent drawings and photography.

P. G. WHITE,
Test Engineer,
Nobel *Orenda Engines*

● Looking back over the nine issues of DESIGN ENGINEERING published to date (DE is filed in our office as reference material) in the light of your original aims for this magazine, I believe that you have already made a very real contribution in the field of engineering design in Canada.

I notice, too, a steady improvement in each issue—particularly I would refer to your excellent article on Miss Supertest II (DESIGN ENGINEERING, December).

Technical papers are often very dull—so much so that they constitute an occupational hazard for the design engineer. The account of Miss Supertest, on the other hand, was as fresh, interesting and fast moving as its subject and for this reason most welcome.

As a design engineer, I find that I must have a good storehouse of knowledge on up-to-date production methods and design data from varied fields. These are the tools I work with; but they are useless unless combined with inspired motivation. This is a mental attitude and requires nourishment.

Articles such as yours and others like them help the designer maintain lively interest in engineering design as his way of life.

J. D. ORR,
Toronto *Orr Associates Ltd.*

● May I take this opportunity to thank you for your efforts in publishing the article on vacuum metallizing (DESIGN ENGINEERING, October).

I must comment that I find your publication extremely good in choice of subjects and presentation. I wish you all possible success.

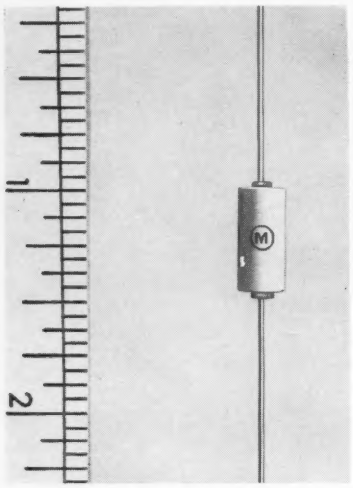
F. Y. WALTERS, JR.,
Philadelphia *F. J. Stokes Machine Company*

New products & materials

New items which can help you on the job

VOLTAGE SENSITIVE ceramic capacitors have been marketed by **Mucon Corporation** with lowered capacitance values that range from 300 mmf down to 100 mmf for those applications where Mucon's type VSR and VSE are not low enough in capacitance. Known as types LVSR and LVSE, the capacitance of these units may be decreased as much as 60% by the application of d-c potential up to 200 volts.

Inasmuch as these units are temperature sensitive, type LVSR has maximum



Low capacity capacitator

sensitivity at room temperature and type LVSE has voltage sensitivity at approximately 70 deg C.

Both of these types are housed in a steatite tube approximately 7/32 in. in diameter and approximately ½ in. long and have No. 26 gauge leads.

The new series of capacitators will have numerous applications in the fields of tuning and frequency control, frequency modulation, harmonic generation and dielectric amplifiers. (200)

• • •

A NEW elastomer made by **E. J. Du Pont de Nemours & Co., Inc.**, is called "hypalon." Chemically, it is chlorosulfanated polyethylene. Unlike its parent material polyethylene, which is a thermoplastic, Du Pont's hypalon is a thermosetting material.

It can be vulcanized and only then develops all its desirable properties. Products made from the material are similar in appearance and physical characteristics to those made from other rubbers. Like other rubbers, the properties of hypalon products can be varied by compounding.

Materials such as softeners, pigments and vulcanizing agents are used to tailor properties to the end use. Products made from other elastomers are also made from the materials. Their outstanding characteristics make hypalon products suitable for applications involving severe service conditions.

Hypalon products are now produced commercially. Heat resistant spark plug boots on some of the new high performance V-8 engines, hot materials conveyors, elevator belts and steam hose covers for example are being made from the material. Flexible, decorative, and protective coatings of the material have been applied from automotive door weatherstrips, to rubber footwear and sporting goods.

Chemical resistant tank linings and acid hose made from hypalon have been proved by over two years service. Added to the rubber in whitewall tires, the material has increased the weather resistance of the blend. (201)

• • •

A NEW COLD cathode type fluorescent lamp that causes no radio interference has been developed by the **Cold Cathode Lighting Corporation.**

The new cold cathode lamp, which is claimed to be the most efficient light source now available for use in sensitive electronic work areas, has been successfully tested by United States Research Laboratories of the various branches within the Department of Defense.

The new lamp is now in use in numerous military installations and has operating characteristics that exceed the radiated interference requirements of the military specifications pertaining to lighting and interference control.

Both the military services and the Federal Communications Commission have announced stringent requirements for the control of all kinds of equipment that cause interference with sensitive communication devices, a policy also closely followed in Canada.

An ordinary fluorescent lamp can cause interference on a TV screen, home radio reception, to an ordinary hearing aid and of more serious consequence to radar reception, guided missile control and ultra high frequency reception equipment.

The cold cathode interference free lamp now meets both military and civilian requirements. The lamp starts instantly and its life is not affected by the number of times the lamp is turned on or off. The lamp operates at lower temperatures and offers exceptionally long life and low maintenance.

The lamp is expected to have wide use in laboratories, testing centres, machine tool work benches and in industry and commerce generally. (202)

• • •

A SMALL COMPACT 30 KW liquid cooled Germanium Power Rectifier occupying a volume of only 190 cubic inches, has been especially designed by **International Rectifier Corporation,** for a-c to d-c power conversion where high power output, high efficiency, negligible ageing and small unit size are required.

This new product may be connected as a three-phase half wave unit, for a six-phase star operation, three-phase centre tap, or as a dual three-phase half

A new power rectifier

wave unit to be used with interphase transformers.

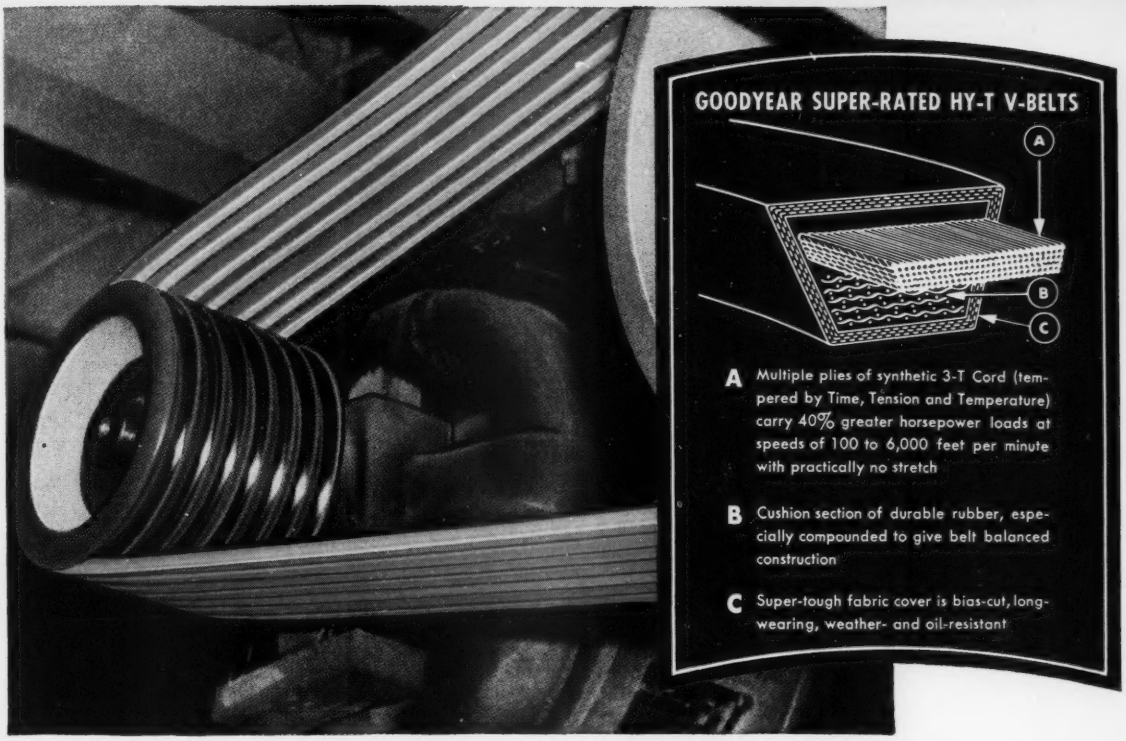
Depending on the circuit, output currents of 540 to 750 maps. can be obtained. The asemblies can be supplied for input voltages of 26v to 66v rms maximum.

The improved rectifier design provides for superior cooling using a liquid coolant such as water or oil at a maximum inlet temperature of 30 deg C and a volume of 1 to 4 gallons per minute.

The rectifier is applicable for all types of d-c load requirements except those requiring heavy surge currents and those subject to heavy intermittent overloads or occasional short circuits.

Unlimited operation life can be expected over a temperature range of minus 55 deg C to plus 75 deg C maximum when equipment is designed to operate within specified voltage, current and temperature rise ratings. This temperature range provides ample safety factor for all normal industrial and commercial applications. (203)

The SECRET of SUCCESS...



is matching!

High speeds and tough shock loads are the efficiency robbers that cause some belts to stretch, to lose their grip or break on multi V-belt drives. Goodyear found the answer to this problem.

The secret of success is matched sets of HY-T V-BELTS. These sets are matched for length, strength, weight and balance. Goodyear matching assures equal distribution of work load for uniform efficiency and exceptionally long service life.

Goodyear HY-T V-BELTS are sinewed with Triple Tempered (3-T) Cords to provide 40% higher H.P. ratings—7 belts can do the work of 10 — or the same number of belts will substantially increase belt service life. Goodyear HY-T V-Belts have oil resisting covers, are mildew inhibited and can be supplied static-conducting.

Each Goodyear Branch has the necessary matching equipment to supply the "sets" to harness your belt killer drives.

GOODYEAR

INDUSTRIAL RUBBER PRODUCTS ENGINEERED FOR THE JOB

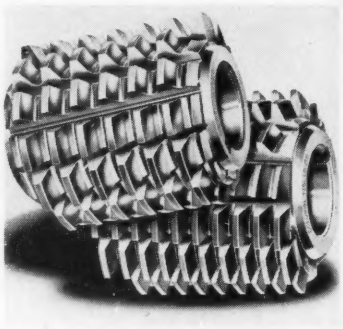
For complete information write or call your nearest Goodyear office at— Moncton, St. John, Quebec City, Montreal, Toronto, London, Windsor, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver, or Head Office, New Toronto.

New products

(Continued)

FULL SCALE operation of a new process for the manufacture of unground hobs to close tolerances has been revealed by **Colonial Tool Company Ltd.** And new facilities that make it possible to produce accurate unground hobs for use where only ground form hobs were formerly considered suitable.

Lower hobbing costs are expected with the company's new accurate unground hobs because of lower tool cost and more production per sharpening. The special high fidelity heat treating process retains the accuracy that is machined into the hob.



Colonial Tool's cheaper hobbing.

Cutting edges throughout the life of the hob are clean, tough, hard and accurate.

Unground "roughing" hobs are also being produced by the process. (204)

• • •

NEW MERCURY LAMPS with rugged glass bulbs that resist breakage from exposure to snow, rain and other hazards have been produced by the **Canadian Westinghouse Company.** Known as "Weatherduty" they are available in 400 and 1,000-watt ratings, designed for both outdoor and indoor lighting service, interchangeable with regular mercury units of identical sizes.

The new lamps are ideal for outdoor use in open fixtures or enclosing types which are not completely watertight. Indoors, their strong bulb construction brings improved illumination, since removing cover plates and wire guards from reflectors will be practical in many applications.

For ventilated fixtures, the units have the ability to withstand the corrosive effects of industrial fumes and damage from water splashing through reflector openings. (205)

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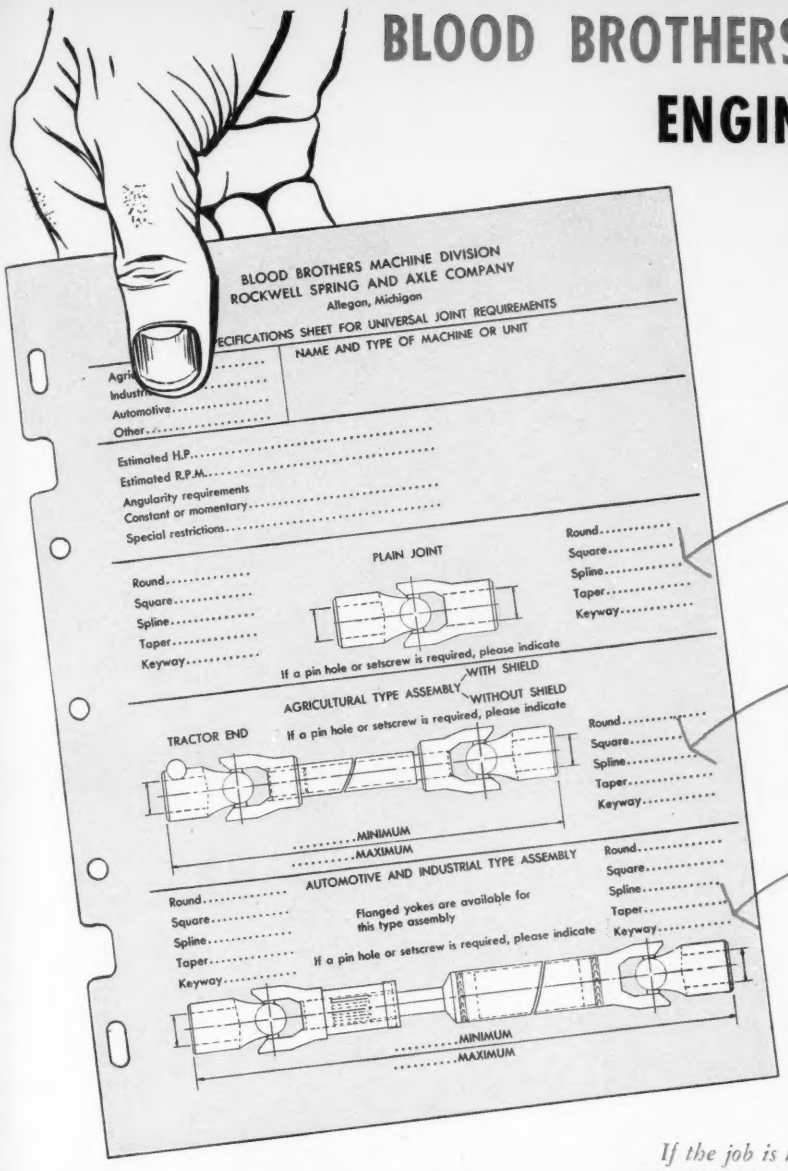

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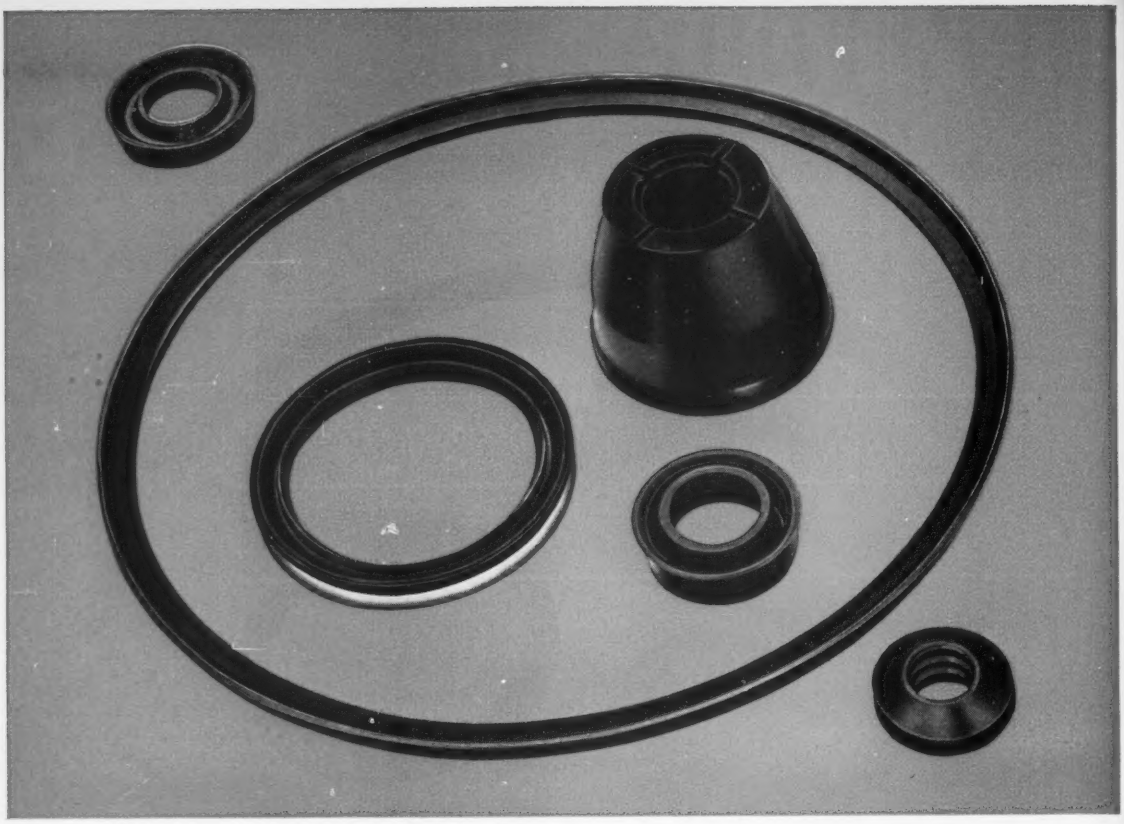

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Stainless steels

(Continued from page 49)

by nickel, of the passivity range established by chromium. They are generally superior to Class I and Class II stainless steels in corrosion serivce but are susceptible to atmospheres containing sulphur and to a type of intergranular deterioration which results from exposure to a critical temperature range. This deteriorating characteristic is variously known as "sensitization" or "weld-decay" the latter because it was first identified in welded 18-8 stainless steel.

If 18-8 stainless steel is heated or cooled slowly through 500 deg C to 750 deg C, the complex carbides present are precipitated at the grain boundaries and are characterized by the migration of chromium carbide, with a consequent impoverishment of the chromium content of the crystal grains themselves. This, in itself, is not particularly damaging and the situation can be restored by re-heat-treatment. If, however, this sensitized steel is exposed to a corroding medium, a galvanic or electrolytic couple is set up between the impoverished grain and the chromium-rich particles at the grain boundary, so that disintegration of the grain boundary occurs. By adding other carbide-foaming elements to austenitic stainless steel, it is possible to prevent the precipitation of chromium carbide, when the steel is heated or cooled through the critical temperature range and this causes these other carbides to precipitate instead and such a stainless steel is said to be "stabilized."

The most popular means of achieving this is by the addition of columbium at ten times the carbon content—Type 347 stainless steel. Other distinguishing features of these two steels will be found later in this text. Tantalum, another element added for the same purpose, is usually found in the company with columbium.

Molybdenum is another very useful element for adding to stainless steels. Its principal function is to expand the passivity range, counteract the tendency to pitting, improve corrosion resistance in sulphuric and sulphurous acids (particularly at high temperature) and render stainless steels more resistant to corrosion in neutral chloride solutions and, specifically in sea water.

With the description of the fundamental features of the stainless steels, design engineers will be better able to understand the different types which are available and their special applications.

This description of the characteristics and applications of the principal wrought

(Continued on page 68)

Quotes

Points from current papers and speeches

RADIOACTIVE tracers are being used more and more in automotive research, the first Nuclear Engineering and Science Congress was told at Cleveland in December. In a technical paper by **A. Hundere, G. C. Lawrason, and J. P. O'Meara** of the Southwest Research Institute it was pointed out that radioactive tracer techniques permit a sensitive and quick method of measuring engine wear that can't be done by using other known methods.

Recently this new tool has been used to measure engine deposits, as thin as ten millionths of an inch, a research team from California Research Corp., comprised of J. G. Mingle, H. W. Sigworth, and B. A. Fries, announced. Also deposition rate can be indicated after only a few hours compared to tens of hundreds of hours by conventional methods.

Metal transfer between electrical contacts has been measured accurately by this method, according to C. R. Lewis of Chrysler Corporation, in his paper "Electrical Contact Studies with Radioactive Tracers." This new research technique is so accurate that a teaspoonful of radioactive salt dissolved in Lake Erie could be detected and measured, he said.

Essentially the technique consists of activating an engine part in a nuclear reactor, then assembling it into an engine. As the engine is operated any change (or wear) in the original part can be detected by a geiger counter. This technique is varied to obtain different data.

• • •

CAST IRON has always been considered to be a rather difficult material to tin by the hot-dipping process. The difficulty arises from the presence of graphite in the structure of cast iron, which can appear as outcrops or smears at the surface, states **C. J. Thwaites** in the Quarterly Journal of the Tin Research Institute.

Broadly speaking suitable preparative procedures aim either at removing surface graphite, or at covering it over with a readily tinned metal.

The Kolene process and the fused nitrate process remove the graphite by oxidation. The second category involves plating with pure iron or copper prior to tinning.

During the war years, efforts to discover a less-complicated procedure for a specific task, resulted in the development of the fused chloride process. In this, surface graphite is partially removed by grit-blasting and the surface is finally prepared by a short immersion in an eutetic mixture of sodium and zinc chlorides at about 300 C. The use of fused chlorides instead of acid for final pickling prevents graphite smear.

More recently, a modification of this procedure, called the direct chloride method, has proved very successful in certain applications. The direct chloride method was first developed for certain high-phosphorus irons which could not be tinned by the fused chloride salt-bath method, because of the risk of overtreatment. It has since been found suitable for grey cast irons and has been used successfully for Meehanite and spheroidal-graphite irons.

• • •

THERE IS NO other industry operating today in which arc welding plays so complete and useful a part as in the petroleum industry, stated **Mr. K. D. Taylor** at a recent Oil Production and Refining Conference in Edmonton.

Arc Welding is conspicuously present in all phases of the industry. It is used at the drilling rig, tying in the well to the battery, from the battery through the gathering system and pipelines to the tank farm or refinery and extensively in the refinery itself. It has proved to be a very useful tool in building, maintaining and modifying installations used to find, move and process various products of the industry.

There was not time to discuss all the phases of arc welding and so the speaker restricted his remarks to a brief discussion of the welding of low alloy piping: the welding of stainless steels: and the welding of carbon steels, particularly those for low temperature service.

• • •

RECORDS OF cylinder pressure versus crank angle have long been used in analyzing the performance of reciprocating engines. The importance of that data to the study of the characteristics of internal combustion engines and their fuels has effected the development of many systems for obtaining quantitative engine pressure diagrams.

Systems for obtaining pressure diagrams may be grouped into two general classifications. Those which yield instantaneous curves of each complete engine cycle, and those which yield a composite curve representative of many engine cycles. Instantaneous curves are very useful in engine studies. However, inasmuch as the pressure-crank angle relationship within a cylinder does not precisely repeat itself every engine cycle, a composite curve is generally required, so that average characteristics can be ascertained.

Several systems for obtaining composite data have been developed and used throughout the industry. However, they have generally exhibited two major disadvantages: (1) their inability to yield data which is either an accurate average or a true representation of the instantaneous values occurring during many cycles, and (2) the relatively large number of man-hours required to obtain the data.

An automatic recording system, the Balanced Diaphragm Remote Plotter, recently developed at the General Motors Research Laboratories, was the subject of a lecture, given at the SAE annual meeting, by **Mr. R. R. Bockemuehl** and **Mr. E. F. Weller.** The new system possesses three important features which eliminate the major disadvantages inherent in previously developed systems.

First, the curves plotted by the system are obtained on a statisically sound basis and are truly representative of many engine cycles.

Second, the system automatically records the pressure-crank angle curve with equipment located remote from the engine, without operator attention other than for initial adjusments, and with a minimum of installation complexities.

Third, the data is recorded in continuous analog form, to a relatively large scale, on standard strip chart paper.

The general function of the Balanced Diaphragm Remote Plotter is to regulate a reference pressure to that value which exists within the engine cylinder at a specific crank angle and to record the resulting relationship.

• • •

THE SUBJECT OF a lecture delivered at the Nuclear Engineering and Science Congress by **John L. Kuranz** was The Use of Radioisotopes in Material Testing.

The paper discussed the use of radioisotopes as analytical tools. The following techniques in the field of material testing were described: isotope dilution and derivative method for rapid quality control: motor oil, gasoline and other engine analysis with radioactive rings: precision determination of hydrogen and carbon in liquid petroleum products using beta absorption: density and thickness control with beta and gamma gauges: determination of tracer amount of impurities using neutron activation analysis. In addition to summarizing the performance of isotopes as testing tools.

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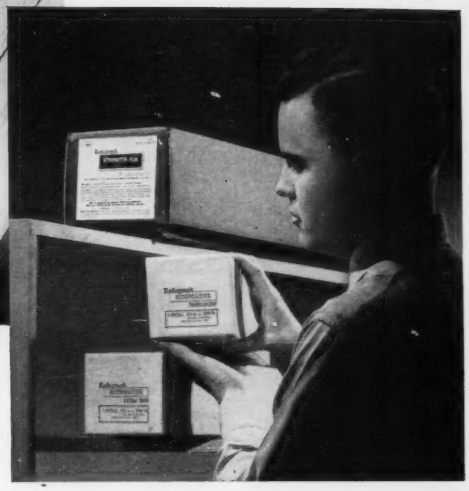

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Stainless steels

(Continued from page 65)

stainless steels is intended to show why stainless steels are stainless and which steels are best for a particular atmosphere or environment. This, it is hoped, will help the design engineer choose the correct stainless steel for a given purpose.

The list of steels dealt with is far from being complete, as there are always some engineering designs which require a special material. Some of these "specials" have been found to have very attractive properties in fields other than the one for which they were designed, the precipitation-hardenable stainless steels being one instance. Stainless steels similar in type to those mentioned are also available as castings, but an examination of these must be left to another time. ★

Oil burner motor

(Continued from page 43)

between 8 and 16 amperes increased the life of master switch contacts 5 times.

No change was made in the wire enamel used on the main windings because no new enamel has yet shown either marked economy or improvement in characteristics. Glass wound auxiliary wire is used but will probably be replaced by silicon enamel wire which is showing great reliability in service.

The company used mylar coated paper for ground insulation since they did not represent either a costly portion of the motor nor one requiring much improvement from a service point of view.

Nothing radical was attempted in the bearing. The company definitely favors bronze bearings on a high torque motor, but in the case of a motor as small as this there appears to be no objection to babbit bearings and there is less noise.

Felt washering is used. While slightly more expensive than wool waste, it holds more oil and is more controllable in manufacture. Deeply drawn oil caps inside the motor help keep oil out of the windings and in the bearings.

A cardinal rule in both cost reduction and product improvement is to reduce the number of parts as much as possible.

The combination of motor nameplate and thermal device mountings is fairly obvious in the illustration. The assembly man puts the thermal through a hole in the shell as he puts the stator into the shell. He snaps it into place in the spring dips provided on the nameplate, fastens the nameplate down, and the whole job is done. In spite of small size, there is no crowding of parts in the motor. Except to tape one end coil to pass through the relay no coil is formed or shaped in any way from its normal shape as placed in the slot. That contributes greatly to the reliability of the motor due to the re-

Patents have by-products

The patent law rewards people for inventing new ideas for useful products and making their ideas public. That's the job that our patent system was set up to do. But it has some valuable economic byproducts, too. For instance, the whip hand that the owner of an important patent has in an industry often drives his competitors to "design around" the patent and develop something just as good or better.

When Harvey S. Firestone wanted to get into the pneumatic tire business, he found that the G. & S. Clincher Tire Association had controlling patents on the only pneumatic tire rim then known. And their control of clincher rims enabled them to put limits on the production of pneumatic tires by everyone in the industry. Firestone asked for a license to use these rims but was turned down. So he invented a rim of his own. It made the clincher rim obsolete and the whole industry soon adopted it.

More recently, research in the foam rubber field was stimulated because one firm was using basic patents on its process to control the whole industry. Charging a 3½% royalty for the use of the process, it restricted production and sales areas and set minimum prices.

Realizing that the patents were based on the use in the process of a foam stabilizer, like soap, one competitor went ahead on its own to develop a foam rubber process that worked without a stabilizer. What happened then?

The first firm cut its royalty rate to 2% and dropped the restrictions on users of its process. Yes sir, patents have byproducts! (By Roy Jackson.)

duction of coil damage. Yet adequate electrical clearance is maintained.

All electrical parts are complete in the stator assembly. The assembly man only has to mount the thermal device and pull the leads through the appropriate lead opening. There are no leads or connections which are partially on one portion of the motor and partially on another.

It took 17 months from layout to regular production. While the shop was rolling out the first quantity production of this motor, the first preliminary layouts of the next oil burner design were being made. However, the design is more radical and because the tooling cost will be higher it will probably be 1958 or 1959 before it reaches production. ★

Seat ejectors

(Continued from page 53)

his legs to the seat at the moment of ejection to resist the tendency of the airstream to force them harmfully apart; at the same time it protects his legs against flailing.

The company claims that it has also answered the need for stabilizing the seat with a small drogue parachute which is released automatically from the head set one second after ejection. This drogue also acts as an air brake. Four seconds after it is released the pilot is tipped from his seat and his parachute opened.

Martin-Baker has made countless experiments (including live ones) to prove that the design works. And now a real emergency ejection has successfully taken place. Why, then, the expensive experiments in the Mojave desert?

The answer seems to lie in a feeling among American designers that the British seat uses too many gadgets. Probably within the next year or so, American airmen will be equipped with newly designed seats, the result of huge expenditures on research, which give good protection with simpler operation. In the meantime, with the painful example of George Smith to remember, few supersonic ejections are to be expected from army or navy fliers in the U. .S. ★

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Patents

Some new ideas win protection in Canada

AN ELECTROLYTIC process for bodying oils for making wrinkle coatings, invented by Peter Pawlyk of Indianapolis, has been patented in Canada by New Wrinkle Inc. of Dayton, Ohio. According to Canadian Patent No. 517,201, issued October 4, 1955, the new method enables the degree of bodying to be accurately controlled and improves the purity of the oil.

Suitable oils are tung oil, castor oil, linseed oil and soya bean oil. The oil is caused to react at the anode of an electrolytic cell, and the resulting oxidation, polymerization and degradation complete the bodying operation. The reaction can be halted at any desired point, thus producing an ideal wrinkling oil.

• • •

A SIMPLE beating device to improve the performance of a vacuum cleaner has been patented by German inventor Eberhard Worwag of Stuttgart. As described in Canadian patent 516,889, issued September 27, 1955, the idea provides that a resilient rubber plate is fastened on one side of the cleaner air inlet so as to close the passage. When the cleaner is operated, the vacuum action pulls the other edge of the plate up into the cleaner and allows air to rush in. This releases the air pressure on the plate, so that it straightens out again and closes the opening, and it strikes a blow on the carpet at the same time.

The outside air pressure now acts on the plate again and it is again bent up into the cleaner. The cycle is rapidly repeated to produce a vibrating, beating action on the carpet. Small lugs or ridges on the bottom of the plate increases the efficiency of the beating action.

• • •

A DEBURRING tool that is said to be chatterless was patented in Canada on August 23, 1955 by the inventors, William D. Reynolds and Guy S. Randles of Alpena, Michigan: Patent No. 515,951.

The tool has a conical head on a hollow cylindrical shank. The shank has a plug in the other end and a coil spring extending toward the head. The spring pushes against a cutter shaped like the head and arranged in a slot in the head, so that it is pushed forward by the spring and projects from the working face of the head. A cross screw in a transverse bore of the shank holds the cutter loosely in the slot so that it can be pushed back slightly against the force of the spring when the tool is in operation.

• • •

CANADIAN PATENT 517,235 has been obtained by Sunbeam Corporation of Chicago on its electric dry shaver. Sunbeam's prolific designer Ivar Jepson, of Oak Park, Illinois, is named as the inventor in the patent, which issued on October 4, 1955.

The shaver features a motor shaft that is parallel to the cutter blade, thus avoiding the old-style elongated shape and permitting the casing to be made nearly rectangular. An improved crank interconnection converts the rotary motion of the motor, operating at speeds of about 8,000 rpm, to the oscillatory movement of the cutter blade.

• • •

A DEVICE FOR detecting bearing wear on a machine shaft was patented in Canada on September 29, 1955, by the inventor, Lauri Heinoo, of Arvida, Quebec. As described in Canadian Patent 516,658, the device includes an electromagnet with its pole faces on opposite sides of the shaft. There is an air gap between each pole face and the surface of the shaft. A source of constant a-c voltage is connected to the coil of the electromagnet. Wear on the shaft increases the size of the air gap and thus varies the current through the coil of the device.

A METHOD OF removing deposits from the combustion chambers of internal combustion engines is covered by Canadian Patent 516,592 issued December 13, 1955 to The Standard Oil Company, Cleveland, Ohio. Sintered metal pellets are introduced into the intake manifold so as to be carried to all the cylinders while the engine is running. The pellets must have a melting point above 300 deg C and a Brinell hardness number between 3 and 115. The introduction of the pellets is carried on for an extended period of time until the deposits are removed.

The inventor: Arthur R. Klingel, Jr. of Chagrin Falls, Ohio.

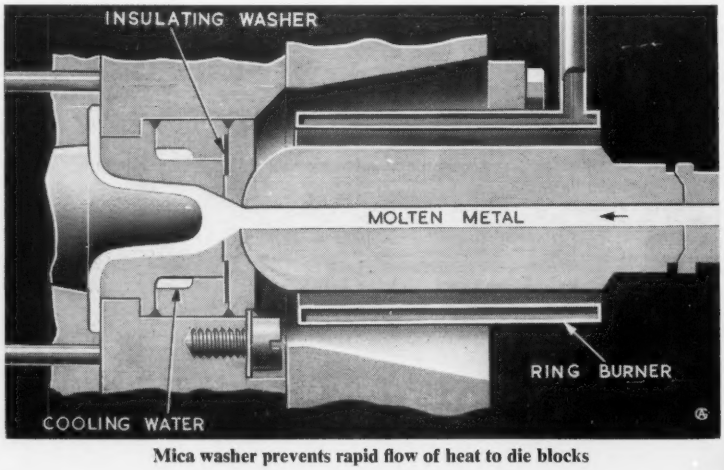
• • •

A COMPOSITE gear wheel with plastic gear segments bolted to a metal wheel centre is covered by Canadian patent 516,939, issued September 27, 1955, to Forano Limitee, of Plessisville, Quebec. The bolts extend through the rim of the wheel centre, and are secured by nuts inside the rim.

• • •

AN ARRANGEMENT for insulating the heated nozzle of a die casting machine from the cool die blocks, so as to prevent rapid flow of heat to the die blocks, is covered by Canadian Patent No. 517,369. The patent, dated October 11, 1955, was assigned to General Motors Corporation by the inventor, A. William Sundwick, of Dearborn, Michigan.

As shown in the drawing, the insulating device is a washer of mica or similar material supported between the metallic parts in a suitable opening in the stationary die block. This limits the metal-to-metal contact between the die block and the hot nozzle to a minimum, and means that the metal in the gooseneck-to-die passage can be kept fluid without interfering with the proper solidification of the castings.



Mica washer prevents rapid flow of heat to die blocks

MISSING PAGES 73-74, READER SERVICE CARD

File

New booklets and books written for you

A NEW BOOKLET, which summarizes most of the information on the newest nickel alloy from **The International Nickel Company of Canada, Limited** is now available.

Titled "Introduction to Nionel," the booklet outlines the chemical and physical properties of the alloy and suggests several promising applications.

Among the applications indicated for the alloy, which has the specific ability to withstand certain hot acids and oxdizing chemicals, are the handling of sulphuric acid solutions, sulphurous acid, phosphoric acid, nitric acid, organic acids, sea water and chlorides. (206)

• • •

SPRAY VALVE Panels, a new development by the **Farval Corporation** designed to spray-lubricate bull gears, girth gears, and other spur or herringbone gear trains, are described in a new bulletin from the company.

The self-contained panels are fastened to gear housing or framework and spray the lubricant directly to the pressure side of the gear teeth. Measuring approximately two feet by three feet, the panels feature stainless steel spray valves having built-in nozzles. Central pumping units deliver gear lubricant at regular intervals through a circuit of Dualine measuring valves. The measuring valves distribute the lubricant under pressure to the spray valves where it is mixed with air to form a penetrating spray, according to the publication. (207)

• • •

NEW PRICING information concerning Carboloy Standard tools and blanks is contained in a publication from **Canadian General Electric Company.** Another new bulletin gives pricing information on standard products in the new 300 series of Carboloy grades.

These new publications contain price lists, specification data and complete ordering instructions and show a new method of grouping cemented carbides into three groups for pricing. (208)

• • •

A NEW SERIES of ball bearings designed for medium duty service conditions has been added to the 30,000-hour Dodge line. Sold by the Dodge Manufacturing Division of United Steel Corporation Limited, they are described in the company's new catalogue. Designated as Dodge SCM Ball Bearings, they embody all of the features and dependability of the service tested Dodge SC Ball Bearings. In addition, the SCM Bearings provide more load-carrying capacity and are available in larger shaft sizes. The new line includes both ball bearing pillow block and ball bearing flange cartridge mounts.

The exceptionally rugged semi-steel outer housing of Dodge SCM Pillow Blocks provides greater strength with trim, streamlined appearance. Full self-alignment is provided by the spherical outer race of the ball bearing inner unit, which fits accurately into the spherical seat in the semi-steel housing.

Metallic-backed synthetic seals are mechanically anchored in position and will not blow under grease gun pressure. The lubricant is effectively sealed in; dust and dirt are excluded. A locking pin prevents rotation of the outer bearing race while allowing full self-alignment. The bearing is securely locked to the shaft by means of two set screws. (209)

• • •

A NEW MODEL of the Power Meter made by the **Polarad Electronics Corporation,** is described in a bulletin from the company. This new instrument, Model P-2, operates over the entire frequency range of d-c to 11,000 mc. Power is measured in three ranges: O-1mw, O-10mw, and O-100mw. Power readings may be accurately and quickly checked by a self-contained d-c calibration circuit.

The Polarad Power Meter is a true RMS milliwatt indicating meter that measures CW and pulse power in milliwatts and db with a minimum of + or —1.0 db accuracy over the entire band. This unit is also insensitive to line voltage changes or frequencies. (210)

• • •

A NEW BULLETIN from the **Allen-Sherman-Hoff Co.,** covers the design, operation and advantages of A-S-H Type C materials handling values.

This four-page bulletin uses photographs, schematics and line drawings to illustrate valve construction and operation. The publication lists advantages of Type C valves in the company's pneumatic ash handling systems and describes self-feeding design, leak-proof construction, non-plugging and non-sticking operation with high concentration and minimum wear.

One section is devoted to an explanation of the control techniques that can be used with air-electric remote or manual operation. Another section covers important factors in designing a collecting hopper for proper flow of material. (211)

• • •

A THREE-PAGE Nicrobraz engineering data sheet describes the new Nicrobraz Paste, a stainless brazing alloy in paste form available from Stainless Processing Division, **Wall Colmonoy Corporation.**

Nicrobraz Paste composition and properties as well as outlining some of the best recommended brazing applications are discussed. (212)

Book Department

Turboblowers

THERE HAVE been, in the last 15 years, many changes in the use of turbo-machinery for the compression of gases and vapors.

Turboblowers by **A. J. Stepanoff, Ph.D.,** deals with the theory, design and application of centrifugal and axial flow compressors and fans. It outlines new methods for attacking turbomachine problems and discusses the art of building turbocompressors.

As well as giving a balanced picture of past and current work in the field, the author explores a number of new methods and techniques. He presents a theoretical treatment of the compressor impeller based on a single pattern of flow, and extends this treatment to the design of centrifugal and axial flow impellers.

The hydrodynamic nature of pressure generation is stressed in contrast with the indirect thermodynamic basis, commonly used in the past. A chapter is devoted to water-cooled compressors and a design method given with detailed numerical examples and a complete energy balance.

The author's design method for an axial flow compressor is based on actual fluid deflection and observed pressure and capacity coefficients rather than on lift and drag coefficients, which are a part of airfoil theory. The latter is discussed sufficiently, however, to show its limitations.

Methods are also given for improving the performance of fans with little or no increase in cost.

The book is well produced by John Wiley & Sons at $8.00.

Vulcanized fibre

(Continued from page 39)

breaker. When a current overload occurs, an intense electrical arc is formed as the circuit breaker opens. This arc jumps the gap between the contact points and is drawn upward through the circuit breaker arc shutes. In a split second, the neutral gas emitted by the vulcanized fibre quenches the hot arc, thus protecting expensive equipment from damages.

And, because it is a tough, strong material, vulcanized fibre is also used for mechanical applications in the circuit breaker—bushings, pins, sleeves, washers and connector bars.

Another electrical use for vulcanized fibre is in lightning arresters for heavy duty outside transformers. This is another example of how a fibre part costing only a few dollars protects equipment worth thousands.

Other characteristics of vulcanized fibre, its good dielectric strength, tensile strength, flexibility and resiliency, make it an ideal insulating paper for armature slot cells. The grade known as Peerless Insulation (fish paper) is used widely to insulate coils and windings in motors and generators. In the form of corrugated strips, it is largely used as duct forms in electrical transformer construction (for both air-cooled and oil-immersed types).

Bone fibre grade is generally used for gears because of its superior machinability. Fibre gears are designed with face widths about twice that of metal gears for equivalent stress conditions.

Also extensively employed in industry are vulcanized fibre collars for self-locking nuts. When the nut is screwed on a bolt, the bolt cuts a set of mating threads on the inside of the fibre collar. Resilient fibre squeezes back against the bolt preventing the nut from working loose under vibration. When the nut and bolt are assembled, the natural elasticity of the fibre tends to restore the original shape of the collar, so the nut can be used many times without loss of gripping action.

This resiliency of vulcanized fibre makes it a good gasketing material. Small amounts of plasticizer, added during fabrication, increase its pliability and improve its airtight sealing ability.

An endless variety of washers and other related parts can be made from vulcanized fibre. Steps used on their fabrication include forming, punching, shaving, swedging and contouring. ★

Advertising index — February

Editorial

A spring date engineers should try to keep

THERE IS a very important spring date coming for Canadian engineers to remember. On May 14, the Design Engineering Show opens its door in Philadelphia. It runs four full days until May 17 and promises visitors some very valuable viewing.

Without doubt, all Canadian engineers in industry have good reason to attend. Certainly it is not easy to find time in busy office schedules for prolonged out of town trips; but just occasionally it is important to try. Here is one of these occasions coming up.

For the engineer's biggest simple problem today is perhaps the difficulty of keeping up to date. What week passes without news from somewhere of discoveries that mean industrial progress? And these same discoveries which put a new spurt into the sections of industry that know of them are harmful to those that do not. The company that does not learn does not, for long, compete; the new idea that means more business for some, surely means less for others. How, then, to make sure of staying part of the prosperous group?

The Design Engineering Show can help with this. There, in Philadelphia's huge Convention Hall, a wonderful assembly of exhibits will be set out with the sole object of showing design engineers the latest examples of industrial know-how on offer.

Over 150 manufacturers will be represented; each will have skilled technicians in attendance. And a glance at the list of exhibitors leaves no doubt that theirs will be a serious contribution. For these are the big names in American industry.

Design Engineering believes that Canada's industry faces a challenge which is in many ways unlike its American counterpart. Without doubt, for instance, there are great production differences; it seems probable, too, that consumer taste in Canada is less like American taste than is often supposed. And besides all this there is grave need for fuller creativity and independence here. But none of this alters the fact that there is still much to learn from our southern cousins.

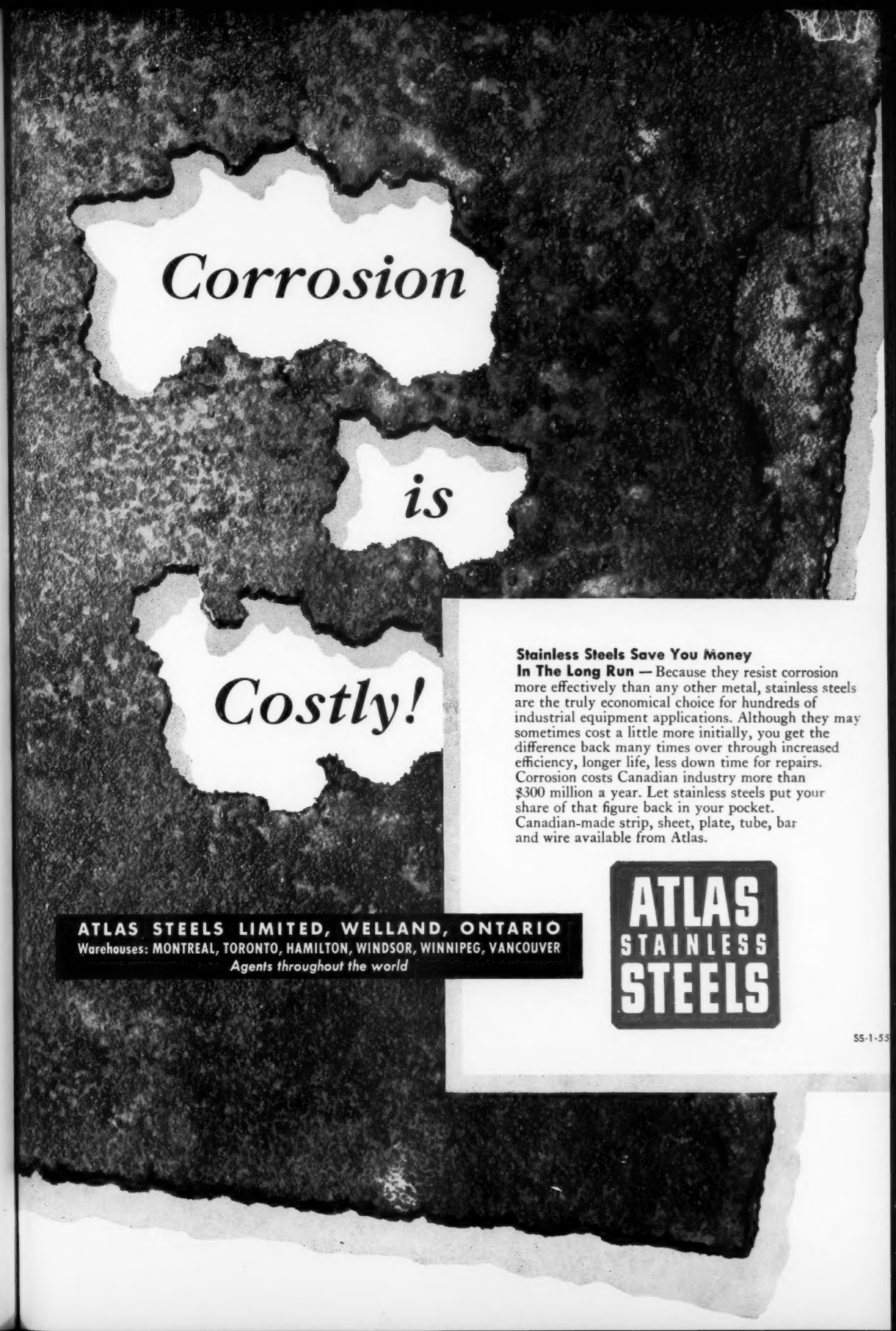
For those engineers who cannot journey to Philadelphia, the editors are planning feature coverage of the show. This will ensure that no Canadian engineer need go uninformed of the great venture aimed at adding to his education.

But no general article, or series even, can take the place of the show itself.

Few industrial problems are broad ones. In these days of complex technology, the all-purpose engineer is nearly extinct. He has been replaced by the specialist, with immense knowledge of his own subject. This is as true in Canada as anywhere.

It is at the Design Engineering Show that specialist can meet specialist. Industrial engineering problems will be so fully covered that few visitors, however restricted their interest may be, will be disappointed.

The editors of **Design Engineering** will be there. And it is their hope that among the many engineers they meet will be a good proportion of their own readers who feel that four days spent studying American industrial genius are days well spent.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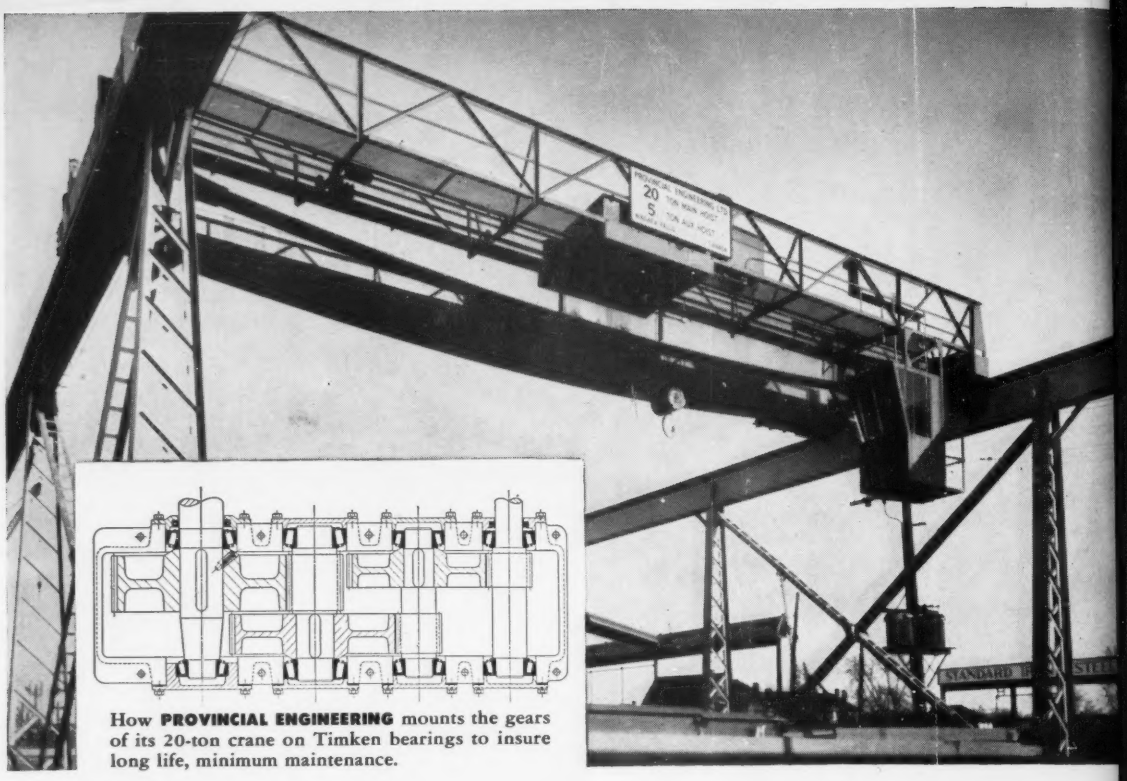

How **PROVINCIAL ENGINEERING** mounts the gears of its 20-ton crane on Timken bearings to insure long life, minimum maintenance.

TIMKEN bearings keep Provincial cranes on the go—and have for 13 years

THIS 20-ton overhead traveling crane made by Provincial Engineering Limited uses 33 Timken tapered roller bearings to keep it on the go.

Timken bearings are used in the gear boxes which employ single helical gearing. Due to their tapered design, Timken bearings take both radial loads and thrust loads in any combination. And full line contact between rollers and races gives Timken bearings extra load-carrying capacity. They hold crane shafts in rigid alignment, reduce gear wear, lengthen gear life. In addition, Timken bearings practically eliminate friction with their true rolling motion. The result—the crane operates smoothly and easily.

Also of importance, maintenance and lubrication costs are held to a minimum. Timken bearings hold housings and shafts concentric making closures more effective—dirt stays out, lubricant stays in.

Little wonder, then, that Provincial, like so many other manufacturers of fine machinery, look for the trade-mark "Timken" on every bearing they buy. Timken bearings make all machinery run better, last longer. Whether you buy or build machinery, make sure it has Timken bearings.

The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

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U. S. PLANTS: Bucyrus, Canton, Columbus, Mt. Vernon, New Philadelphia, Wooster, and Zanesville, Ohio; Colorado Springs, Colorado.

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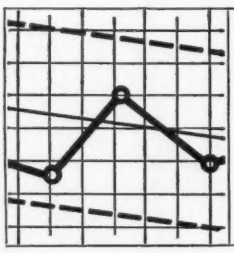

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